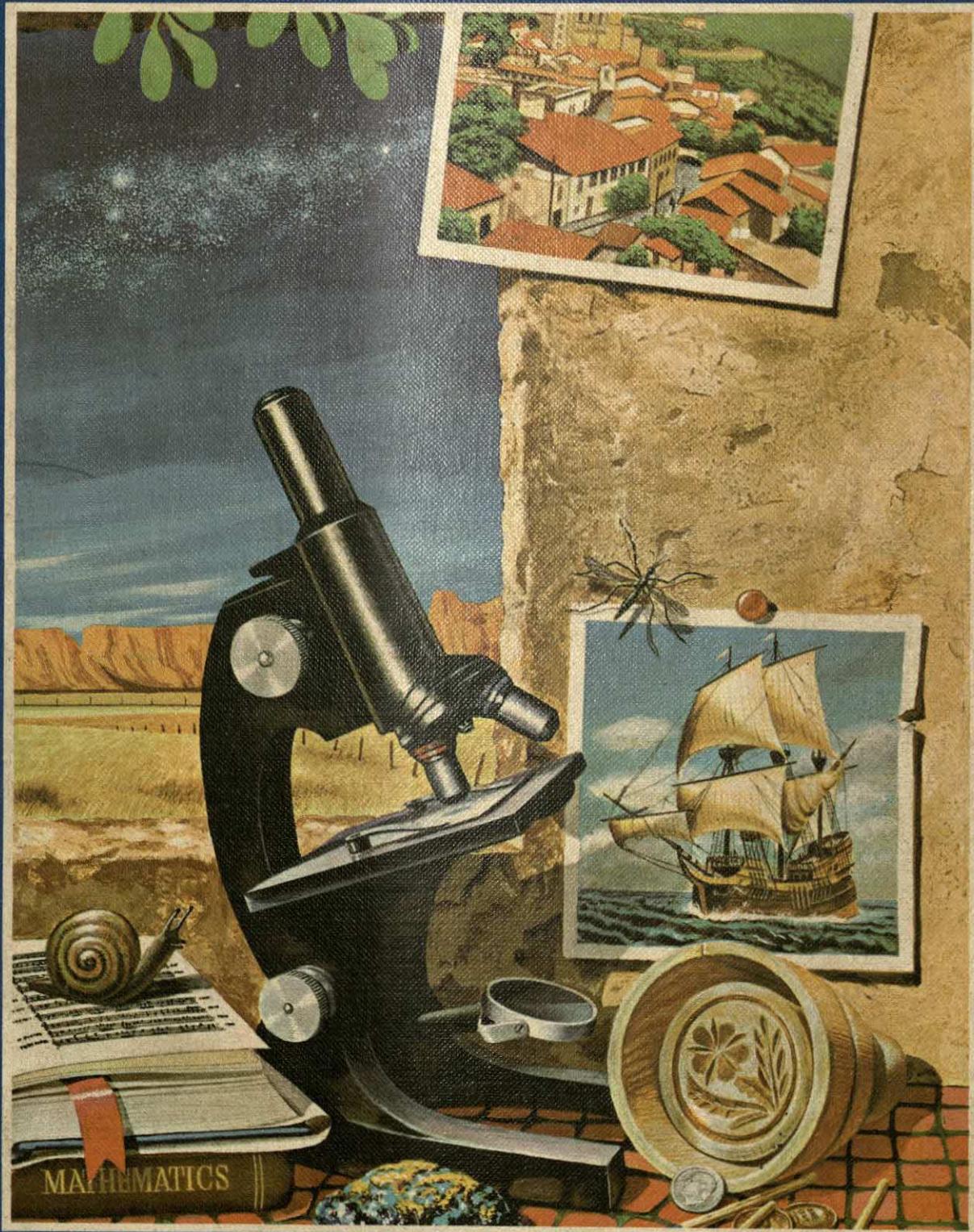


Volume 10 Mathematics to Natural Gas

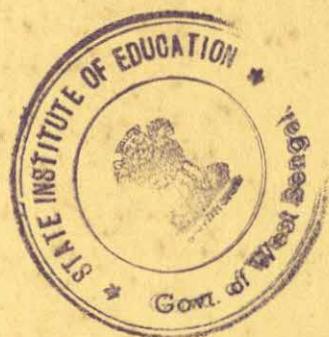
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FORMERLY OF THE LABORATORY SCHOOLS, UNIVERSITY OF CHICAGO
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M athematics N to Natural Gas

MATHEMATICS In school boys and girls study mathematics. Counting, adding, subtracting, multiplying, and dividing are a part of what they learn. Schools teach mathematics because it plays such an important part in our lives. How could we do such things as figure time, make change, build houses, or even keep score for a game without knowing about numbers?

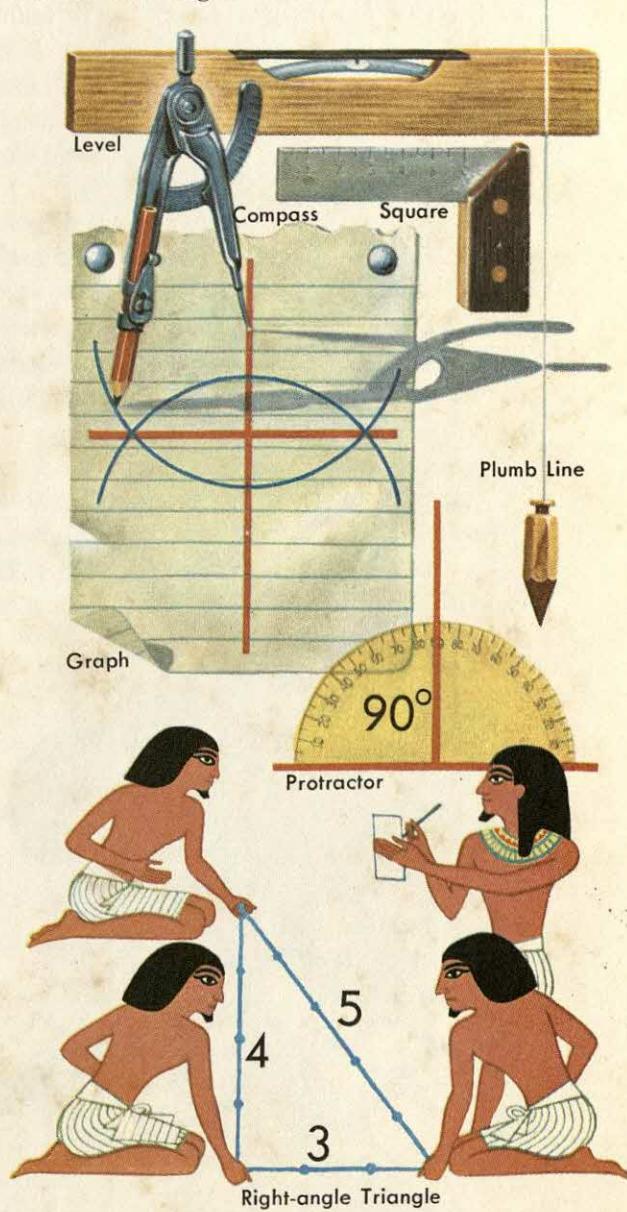
Simple calculation with numbers, or arithmetic, is one branch of mathematics. Among the many other branches are geometry, algebra, trigonometry, and calculus. Mathematics has grown as the need for it has grown. Topology is one of the newer branches.

When men first began trading with one another they needed ways of counting and measuring. They had to decide how *many* animal skins they would trade for a new spear. As trade grew, they had to decide how *much* silver they would give for a certain amount of spice or silk. When merchants began keeping records of their business they had to invent signs to stand for numbers. The ancient Egyptians, Babylonians, Greeks, and Romans all had number signs. But it was easier to add, subtract, multiply, or divide with a counting frame, or abacus, than with their written numerals.

From India came the ancestors of the number signs we use today. The mathematicians there probably invented zero and developed the use of fractions. The Arabs adopted the number system of India

and brought it to Europe during the Middle Ages. This system made calculating easy.

Geometry has to do mostly with form—with such things as angles, triangles, circles, and spheres. The word geometry comes from two Greek words that mean "earth" and "measure," and we find the beginnings of geometry back in a time when people first needed to measure parts of the surface of the earth. In ancient Egypt the Nile River overflowed its banks each year and dumped tons of mud over the farmland in the river valley. Each farmer had to mark out his field again after the water went



down. To know exactly how much land was his, he had to work out ways of figuring area.

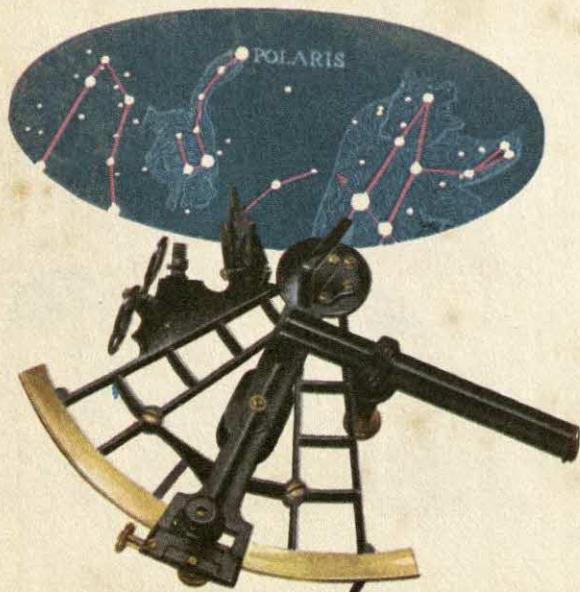
In measuring their land, the Egyptians broke it up into triangles. They had learned that they could find the area of a triangle (\triangle) by multiplying the width by the height and dividing by 2. They worked with circles, too, and found out that the circumference of a circle is about $3 \frac{1}{6}$ times its diameter. The Babylonians also worked out good ways of measuring and calculating.

But before the time of the Greeks, no one had set down what was known about geometry in an orderly way. About 300 B.C. the Greek mathematician Euclid did so. He made geometry into a system of well-proved rules. His books were used for more than 2,000 years.

The Greeks found geometry very useful for surveying, astronomy, navigation, and architecture, just as we do today. In the third century B.C. the Greek astronomer Eratosthenes, by using geometry, calculated that the earth was 24,465 miles around. This figure was fairly close to the right one.

The Arabs developed algebra. It is a sort of mathematical shorthand. By using algebra we can state many mathematical ideas with just a few letters and signs. If we want to say, for example, that in any

Sextant, a Help in Navigation



circle the diameter is twice the radius we can write: $d = 2r$.

Gradually other branches of mathematics have been added. Mathematics today is of great use to many other sciences. Mathematics, however, is much more than a tool. It is a way of thinking—of drawing sound conclusions from facts.

One recent advance in mathematics is the building of great electronic computers, or calculating machines. In a few seconds a computer can solve problems that might take a man years to solve alone. (See ABACUS; COMPUTER; NUMBERS; WEIGHTS AND MEASURES; ZERO.)

MAYAS Fifteen hundred years ago there was a great nation in Central America and Mexico. Its people were the Mayas. They were highly civilized Indians.

The lands of the Mayas stretched northward from the borders of Honduras and El Salvador to the lowlands of Yucatán. There were many big centers—so-called cities—with temples where people from round about came for ceremonial worship. The Mayas were great builders. They also made beautiful pottery and ornaments.

Many of the Mayas were farmers. Their chief crop was corn. Others were traders. Weather and seasons were very important to both the farmers and the traders. The Maya priests studied the stars. They were astronomers as well as priests. They had a highly accurate calendar and had gone far in mathematics. They wrote in a kind of picture writing called hieroglyphic. Some of the writing was done on a paperlike material made of fibers of the wild fig tree. Some was carved in stone.

The Mayas had dogs, and they kept ducks, turkeys, and bees, but they had no horses or donkeys or llamas or oxen. They had no metals for tools and weapons. The gold and silver for the ornaments they made had to be brought from far away.

Wall paintings from an early Maya temple tell much about how these Indians

lived. One picture shows a great procession. In the procession there are gorgeously dressed nobles and priests. There are musicians with big wooden trumpets, rattles made of gourds, and drums of tortoise shells. There are also paraders in masks.

Another picture shows a priest being dressed by servants. He is wearing a costume made partly of jaguar skin and partly of cloth with heavy embroidery. Around his neck he has a necklace of jade. On his head he wears an enormous headdress decorated with plumes of the quetzal bird.

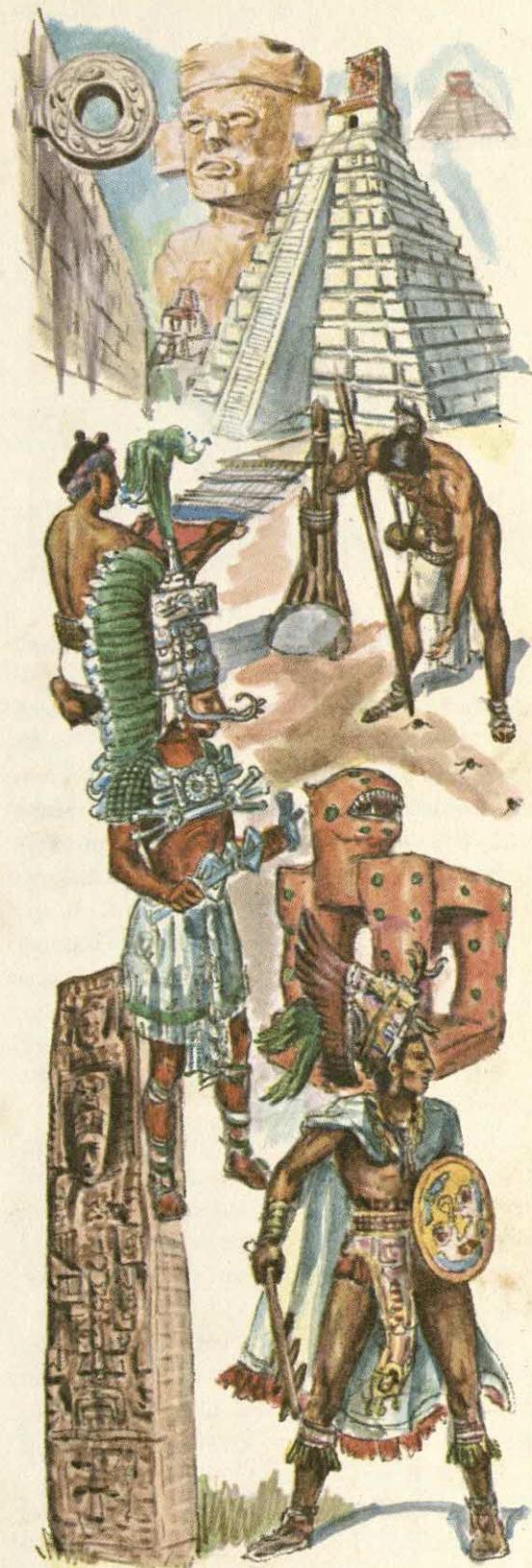
After flourishing for hundreds of years, the Maya temples were deserted and let fall into ruins. Why they were is the big mystery of the Mayas.

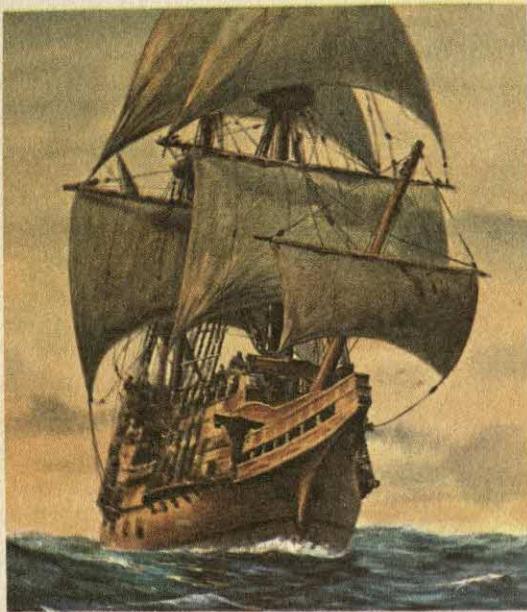
In Yucatán, where Indians from central Mexico had come and mingled with the Mayas, the Maya civilization rose again. The once deserted temple city of Chichén Itzá there was reoccupied in the 10th century and for over 200 years was the leading Maya city.

Many of the buildings of the Mayas were much like the pyramid temple in the picture. Often the stairways and stone pillars of the Mayas were decorated with carved snakes. Their legends told of a fair serpent god who had taught them how to grow crops.

The Ball Court is one of the interesting ruins of Chichén Itzá. High on the wall is a great stone ring. The players tried to knock a hard rubber ball through the ring with their elbows or the upper part of their legs. This game, which was still being played by the Mayas when Spanish explorers came, was a marvel to the Spaniards. They had never seen rubber before.

In about 1200 Chichén Itzá fell to conquerors. By the time the Spaniards arrived in the New World, they found, not a strong Maya nation, but many separate tribes of Mayas at odds with one another. The Mayas' days of glory had passed. But Maya Indians still live today in the lands once occupied by their great ancestors. (See CENTRAL AMERICA; MEXICO; QUETZAL.)





MAYFLOWER The Pilgrims who landed at Plymouth, Mass., in 1620 came from England in a sailing vessel. It was named the "Mayflower." The "Mayflower" left Plymouth, England, on Sept. 16, 1620. Two months and five days later it reached Massachusetts Bay. After a month of exploring the coast, the Pilgrims founded their colony and named it Plymouth.

The "Mayflower" would look small indeed beside an ocean liner of today. There were 102 passengers on the boat. One of them died and one baby was born during the long voyage. The baby was named Oceanus. His last name was Hopkins.

Life on the "Mayflower" during the long voyage was not gay. The Pilgrims were coming to the New World to find a place where they could worship as they wanted to. They knew that there were many hardships ahead of them.

Before they left the boat, the men on board made an agreement. They promised to work together to make just laws, and to obey these laws. Their agreement is called the Mayflower Compact.

The "Mayflower" sailed back to England in the spring. The people of Plymouth must have been sorry to see it sail away.

In 1957 the "Mayflower II," built just like the first "Mayflower," sailed across the Atlantic from Plymouth, England, to Plymouth, Mass. Its trip took 53 days. The ship is now moored in the harbor near Plymouth Rock. Tourists who go aboard get a clear picture of what it meant 350 years ago to cross the sea. (See PILGRIMS.)

MEASLES This disease is often called a children's disease. Adults may have measles, but not many do, because most of them had the disease when they were children. If a person once has measles, he is not likely to have it again.

Measles is contagious: a person gets the disease by being with another person who has it. As a rule, a person comes down with measles eleven days or so after he has been exposed.

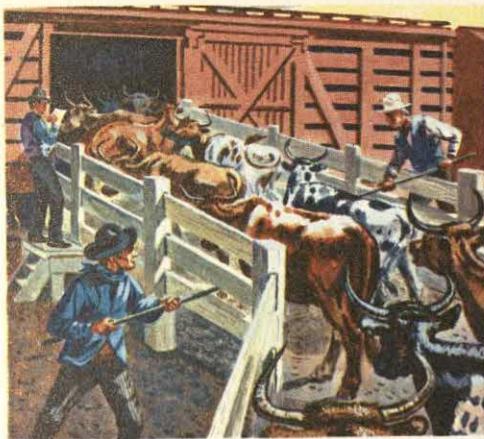
At the start measles is much like a cold. It begins with a headache and sniffles. In a few days the sick person has a high fever. Then he breaks out with a rash. Anyone with measles needs good nursing.

Measles is caused by a virus. Viruses are very tiny disease germs. Fortunately there are now vaccines to protect children from measles. If used widely enough, they may make this disease disappear.

MEAT AND MEAT PACKING In very early times people had to get all their meat from wild animals. Hunting was an important part of their lives. Now most meat comes from animals raised to be butchered. Meat markets where meat can be bought are close at hand almost everywhere.

Our early ancestors had no easy way of keeping meat from spoiling when the weather was warm. They usually had a feast and ate as much as they could as soon as a big animal was killed.

No one knows when people first learned to preserve some of the meat of animals they killed. But long ago they found that they could keep meat fit to eat by drying, salting, or smoking it. Today, in addition



to these old ways of keeping meat, there are other ways. Meat can be kept cold even in hot weather; it can actually be frozen; or it can be canned. The meat of an animal killed now may be eaten many months or even years later.

Meat markets have meat of many kinds for sale. There are the so-called red meats—pork, veal, beef, mutton, and lamb. There are also the poultry meats—chicken, duck, turkey, and goose. Besides, there are such mixtures of ground-up meat and spices as sausages and frankfurters.

Some meats tell by their names what animals they come from, but some do not. Fresh pork and pork cured by salting (salt pork, bacon, and ham) come from pigs. Veal comes from calves. Beef is the meat of cattle. Mutton comes from sheep.

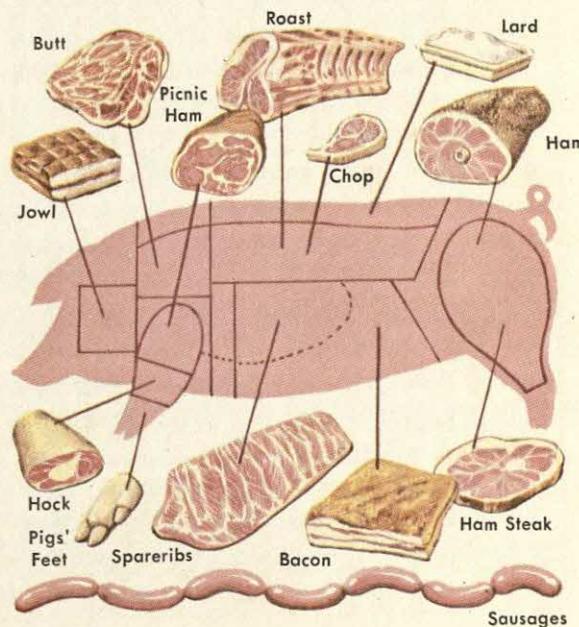
The people of the United States eat so much meat that killing the animals and preparing the meat for market is one of the country's leading industries. The average amount of meat eaten by each person in a year is more than 200 pounds. A hundred years ago most of the meat the people of a town or city ate came from animals brought in from either cattle markets or farms nearby and slaughtered locally. The cut-up meat was then sold in the butcher shops. But since then great stockyards and meat-packing plants have been built. Farmers ship the stock they raise for meat to the stockyards, where big packing plants buy it, then market the meat from it far

and wide. Refrigeration made possible shipping the fresh meat rather than the live animals themselves.

The United States is the leading meat-producing country of the world. Of its cities Omaha ranks first in meat packing.

Great care is taken at meat-packing plants to see that the meat is safe to eat. If a plant sells meat outside the state where the plant is, federal inspectors examine its meat. They stamp each dressed animal they have inspected and OK'd with a purple circle. The purple coloring is harmless. The meat is also stamped to show what grade it is. All the meat that leaves a federally inspected meat-packing plant is safe and clean, but some is especially tender and good tasting.

Only a little more than half of an animal can be used as meat. When meat-packing plants began, almost everything that could not be used as meat was wasted except the hides and some of the fat. Now almost nothing is thrown away. The blood, bones, hoofs, hair, and even the glands are used in fertilizers, soaps, glues, animal feed, skin creams, medicines, paints, plastics, or chemicals. One common saying is that every part of a pig is used except its squeal. (See CAVE DWELLERS; FOODS.)



MEDICINE A mother finds that her baby has a high fever. The baby is so uncomfortable that he cries all the time. The mother consults the doctor. The doctor examines the baby and prescribes treatment. Soon the fever goes down and in a day or so the child is well.

Happenings of this kind are very common. Doctors play an important part in the lives of almost everyone. When we are ill, doctors find out what is wrong with us. They know how to help us get well.

Doctors do even more than help us get well if we are sick. They do much to keep us from getting sick. Doctoring of this kind is called preventive medicine.

Many doctors today are specialists. They treat only certain kinds of diseases or only certain parts of the body. There are, for instance, eye specialists, heart specialists, and specialists in kidney diseases and bone diseases. There are doctors who specialize in making X-ray examinations, giving anesthetics, or treating children's diseases. The list of specialists is very long. Doctors who operate are called surgeons. They, too, usually have special fields.

It takes years of study to be a doctor. In the United States and in most other countries, too, doctors must pass examinations before they are allowed to practice. A doctor not well trained could do much harm.

People have had accidents and diseases as long as there have been people. Doctors have been needed. And from very, very early times there have been doctors. We can get some idea of what the earliest doctoring must have been like from doctoring in some of the primitive tribes of today. In these tribes medicine men are the doctors. They work on the idea that evil spirits in the sick person's body cause sickness. They try, partly with noise and dancing, to drive the evil spirits away.

In ancient Egypt and Babylonia, medicine and religion were closely tied together. The healers were both doctors and priests—and druggists, too. Ancient Babylonian

clay tablets have been found that give the symptoms of various diseases and tell the drugs to use. The tablets end with prayers to the gods. A famous Egyptian papyrus more than 3,000 years old is a collection of 800 prescriptions written by doctor-priests. Some of the medicines of early times were very strange. The Egyptians, for instance, believed that ground-up emeralds were helpful in certain diseases. Poor people who could not afford emeralds had to be satisfied with green porcelain.

Even though the science of medicine began more than 2,000 years ago, strange ideas of treating diseases lasted down through the Middle Ages. For a long time using leeches to draw blood from a sick person was so common that doctors were often called leeches. Nasty-tasting brews were concocted; one idea was that the best medicines were those that tasted worst. For a time surgery was given over to barbers.

To treat sick people intelligently, a doctor must know a great deal about the human body. And people were slow to find out much about how our bodies are built. Scientists knew how the distant planets travel around the sun a hundred years before they knew how our blood circulates.

The science of medicine began with the Greek Hippocrates. He earned for himself the name of father of medicine. Hippocrates taught that every disease has a natural cause—that it is not due to evil spirits. He separated medicine and religion. His students swore to do all that they could to help the sick, to keep in confidence what their patients told them, and not to intentionally harm anyone. Doctors still follow the "oath of Hippocrates."

Many hundreds of doctors have made medicine what it is today. The chart on the next page names just a few of them. As the list suggests, doctors and scientists from many countries are responsible for the "firsts" in medicine. (See DENTISTRY; DISEASES; DRUGS; PSYCHIATRY; VETERINARY MEDICINE; X RAYS.)

NAME	DATES	DISCOVERY
HIPPOCRATES Greece	460?-377? B.C.	Hippocrates, the "Father of Medicine," described many diseases and cures. Doctors are still guided by the Hippocratic Oath.
GALEN, CLAUDIUS Greece and Rome	130?-200?	Galen wrote 500 books that were considered for many centuries to contain all there was to know about medicine.
RHAZES Arabia	850?-923?	Rhazes wrote an encyclopedia of medicine, and was the first to prove that smallpox is a different disease from measles.
AVICENNA Arabia	980-1037	Avicenna's <i>Canon of Medicine</i> listed methods of treatment that were taught for the next 650 years.
VESALIUS, ANDREAS Belgium	1514-1564	Vesalius discovered much about the structure of the human body. He is called the "father of the science of anatomy."
PARÉ, AMBROISE France	1510?-1590	Paré was a great surgeon. He taught men to seal wounds by sewing instead of burning them with a hot iron.
HARVEY, WILLIAM England	1578-1657	Harvey learned the true way in which blood circulates. This discovery was one of the greatest in the history of medicine.
HUNTER, JOHN Scotland	1728-1793	Hunter's discoveries of how the body is built helped make surgery an important branch of medicine.
JENNER, EDWARD England	1749-1823	Jenner made the important discovery of vaccination. He successfully vaccinated an 8-year-old boy against smallpox.
LAËNNEC, RENÉ THÉOPHILE France	1781-1826	Laënnec invented the stethoscope, which enables a doctor to listen to a patient's breathing and heartbeat.
BEAUMONT, WILLIAM United States	1785-1853	Beaumont discovered the function of the stomach in digesting food, and the part played by the gastric juice.
MORTON, WILLIAM T. United States	1819-1868	Morton showed that ether could be used as an anesthetic. This discovery made painless surgery possible.
PASTEUR, LOUIS France	1822-1895	Pasteur completely changed men's ideas about diseases by proving that many diseases are caused by germs.
LISTER, JOSEPH England	1827-1912	Lister found that certain substances, now called antiseptics, can kill disease germs. The use of antiseptics is now common.
KOCH, ROBERT Germany	1843-1910	Koch studied disease germs, and added much to man's knowledge of tuberculosis, anthrax, and Asiatic cholera.
ROENTGEN, WILHELM KONRAD Germany	1845-1923	Roentgen added the use of X rays to medical practice. X rays enable a doctor to "see" inside a patient's body.
FINLAY, CARLOS JUAN Cuba	1833-1915	Finlay was the first to suggest that the dreaded yellow fever is spread by mosquitoes. When Reed's experiments proved this idea was right, a way was at last found to fight this disease by destroying the mosquitoes that carry it.
REED, WALTER United States	1851-1902	
EHRLICH, PAUL Germany	1854-1915	Ehrlich pioneered in the use of injecting chemical substances into the blood stream to kill disease germs.
HOPKINS, FREDERICK GOWLAND England	1861-1947	Hopkins studied the effect of certain food substances on the body. His findings led to the discovery of vitamins.
LANDSTEINER, KARL Austria-United States	1868-1943	Landsteiner's discovery of the four main blood types changed transfusion from an experiment to an accepted practice.
CARREL, ALEXIS France-United States	1873-1944	Carrel worked out ways of transplanting living tissue and organs. He built one of the first artificial hearts.
WAKSMAN, SELMAN Russia-United States	1888-	Waksman discovered the antibiotic streptomycin, the first drug effective against tuberculosis. He coined the word antibiotics.
BANTING, FREDERICK GRANT Canada	1891-1941	Banting was one of the discoverers of the hormone insulin. Prepared insulin is a great help in treating people who have diabetes.
FLEMING, ALEXANDER Scotland-England	1881-1955	
FLOREY, HOWARD WALTER England	1898-	Fleming accidentally discovered penicillin, the first of the antibiotic "miracle drugs," in 1928. Ten years later, Florey and Chain proved that penicillin could be very effective in fighting many different diseases caused by germs.
CHAIN, ERNST BORIS Germany	1906-	
DOMAGK, GERHARD Germany	1895-1964	Domagk gave medical science the first of a new series of drugs—the sulfa drugs—when he found that prontosil kills germs.
SALK, JONAS United States	1914-	Salk won world fame for his discovery of a vaccine to prevent polio. His discovery was announced in 1955.



MEDITERRANEAN SEA The name "Mediterranean" comes from two Latin words which mean "middle of the land." It is a good name for this big sea, for there is land almost all the way around it. The Mediterranean opens into the Atlantic Ocean, but the gateway is very small.

A great deal of the story of civilization is laid close to the Mediterranean. Ancient Egypt, like Egypt today, stretched back from it along the Nile. Ancient Babylonia and Assyria were not far to the east of it. The ancient Greek states were on a peninsula reaching out into it. The heart of the great Roman Empire—the city of Rome—was in another peninsula reaching out into the Mediterranean. The ancient city of Carthage was on the southern shore of the sea. The old cities of Tyre and Sidon were on the eastern shore.

For thousands of years—ever since the days of ancient Egypt—sailors have sailed the Mediterranean. The sea kings of Crete, the Phoenicians, the Greeks, and the Romans were in turn the lords of the Mediterranean. Now ships of almost every land sail through it.

The Mediterranean is a big sea. It is more than 2,300 miles long. It is deep, too. On the average it is a mile deep. The entrance

into it from the Atlantic is the Strait of Gibraltar. This strait is not only the gateway to the sea itself. It is also a gateway to all the countries that lie along the shores of the Mediterranean.

In the Middle Ages, after Europe discovered the riches of the Far East, the Mediterranean was part of a great highway from Europe to the East. The rest of the highway was on land. When an all-sea route around Africa was found, the Mediterranean lost some of its importance. But the digging of the Suez Canal to join the Red Sea with the Mediterranean made the Mediterranean a very important highway to the Far East once more. The Mediterranean is a highway, too, between the countries on its shores and North and South America. Of course, it is still, as it has always been, an important highway between the Mediterranean countries themselves.

There are hundreds of islands in the Mediterranean. The two largest are Sicily and Sardinia. They are a part of Italy. The islands, as well as the countries that border this big sea, have long and interesting histories. Of them, Cyprus and Malta have become independent countries. (See CRETE; GIBRALTAR; GREECE; PHOENICIANS; PIRATES; SUEZ CANAL.)

MEMORIAL DAY The 30th of May is a holiday in most states of the United States. The holiday has two names: Memorial Day and Decoration Day. It gets the first of these names because it is set aside in memory of the men who have died in fighting for their country. It gets its second name because on that day the graves of soldiers and sailors are decorated with flags and flowers. Often there are big parades on Memorial Day. There is always a special ceremony at the Tomb of the Unknowns.

The observance of Memorial Day began soon after the Civil War ended. Many men had been killed in the war, and people wanted some way of honoring them. In 1868 May 30 was selected as the Memorial Day for the northern states. Some southern states chose other dates to celebrate as their Memorial Day. In 1968, just 100 years after it had named May 30 as Memorial Day, the government passed a law, to become effective in 1971, changing Memorial Day to the last Monday in May.

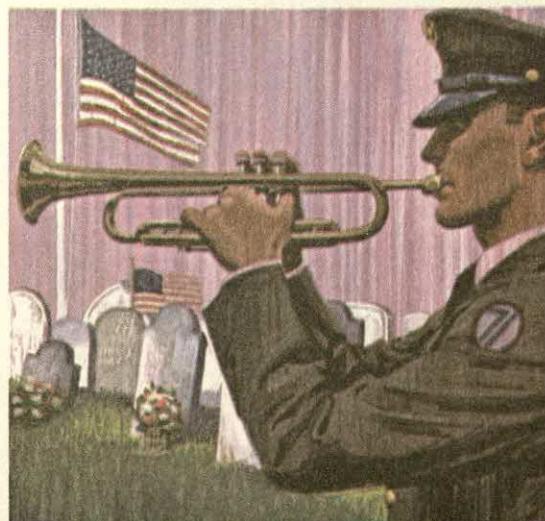
In many parts of the United States Memorial Day is now more than a time for honoring soldiers and sailors. It is a day for decorating the graves of all those who have died. Almost all the graves in many of the country's cemeteries are now covered with flowers on this holiday. (See HOLIDAYS; UNKNOWN SOLDIER.)



MENDEL, GREGOR (1822-1884) Why do tall plants grow from some marigold seeds and dwarfs from others? How is it that there can be puppies of different colors in the same litter? Why are no two oak trees exactly alike? Such questions puzzled scientists for a very long time. One of the first scientists to find some of the answers was Gregor Mendel, an Austrian monk.

Mendel spent a great deal of time experimenting with the plants in the monastery garden. He worked mostly with garden peas. He crossed many kinds and kept a record of his results. His experimenting gave him some ideas about the nature of heredity—about how plants and animals inherit such things as color and shape and size from their ancestors.

Mendel's findings were published in 1866. But no one paid much attention to his work for about 50 years. By that time other scientists had carried on experiments much like Mendel's and their ideas agreed with his. Then Mendel's work was praised. It was called one of the milestones of science. Mendel spent his last years as the abbot of his monastery. He did not dream that his name would someday be famous. (See HEREDITY; HYBRIDS.)





MERCURY The element mercury was named for Mercury, who, in Roman mythology, was the swift messenger of the gods. Anyone who has ever tried to pick up some spilled mercury will agree that the name is a good one.

Mercury is the only common metal that is a liquid at ordinary temperatures. When spilled it forms small balls which roll around so easily that they are hard to gather up. For this reason and because it has a shiny gray color like silver, mercury is also called quicksilver.

The chemical symbol for mercury, strangely enough, is Hg. The symbol was made from the Latin name for this metal—*hydrargyrum*—meaning watery silver.

Mercury is used in many barometers for measuring air pressure. It is also used in many thermometers. Since it freezes at about 40 degrees below zero, however, it cannot be used in the Arctic or Antarctic, where temperatures are often much lower. Mercury batteries, mercury-vapor lamps, and amalgams for filling teeth are a few of the many other uses of this metal.

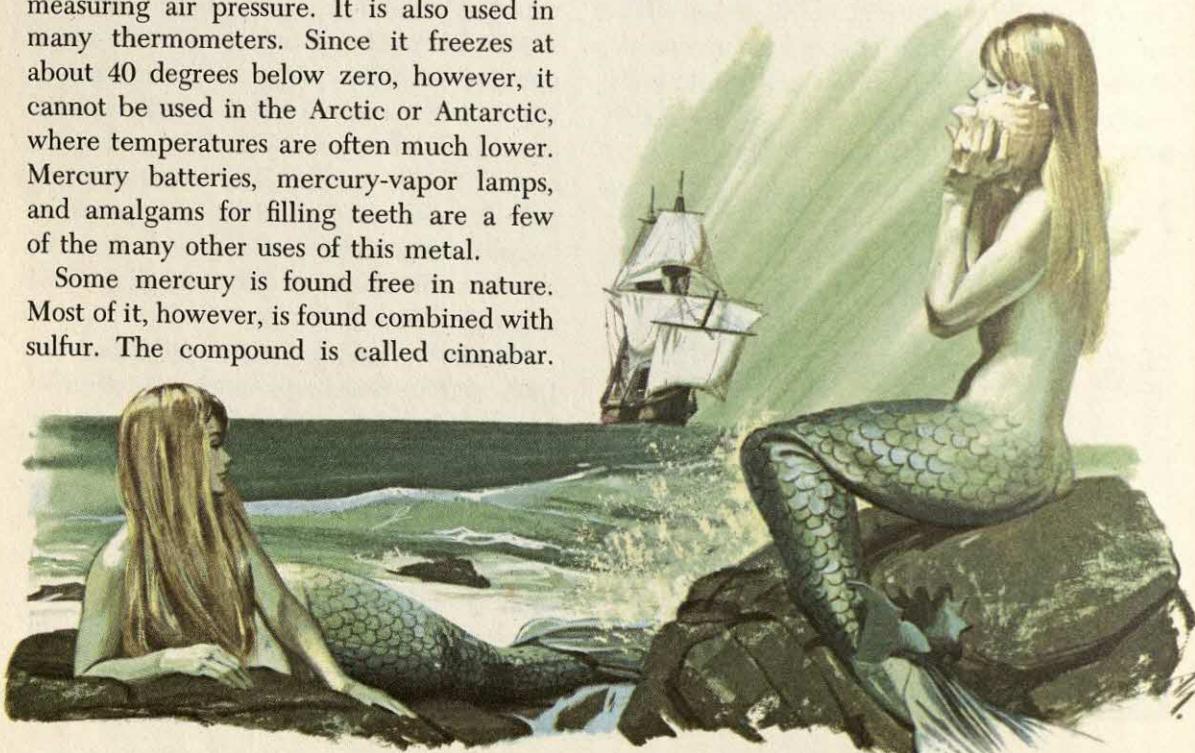
Some mercury is found free in nature. Most of it, however, is found combined with sulfur. The compound is called cinnabar.

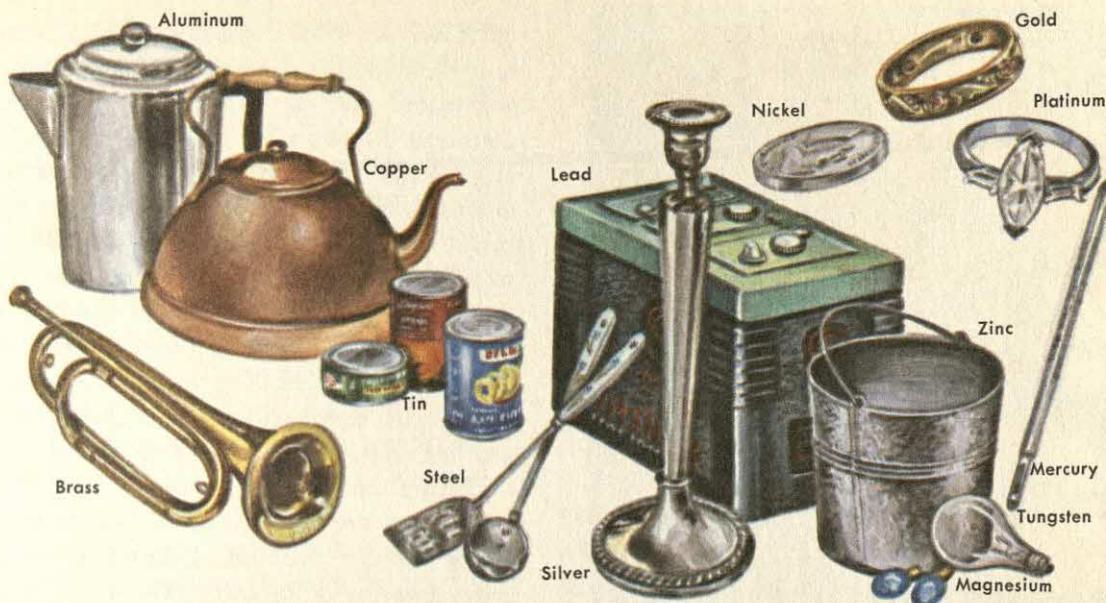
MERMAID There are many old stories about mermaids. These stories come from different parts of the world. There are many pictures of mermaids, too. But there were never any real mermaids.

Mermaids were supposed to be half human and half fish. They were supposed to live in palaces under the sea. In the pictures that were drawn of them they were always beautiful. In the stories about them they often came out of the sea to rest on the shore and comb their long golden hair.

P. T. Barnum, the famous circus owner, once had a "mummified mermaid" in an exhibit. Of course it was a hoax.

The idea of mermaids may have come from something people of long ago really saw. Perhaps it was some mammal that lives in the sea. Mammals cannot breathe underwater. They have to come to the top of the water to get air. Many people think that the mammal that gave people the idea of mermaids was a sea cow—either the manatee or the dugong. But of course no manatee or dugong ever had long golden hair! (See ANIMALS, FABULOUS; BARNUM, PHINEAS TAYLOR; MANATEE.)





METALS Everything in the world is made out of about 100 simple substances we call elements. Nearly three-fourths of these elements are metals. But only about 20 metals are well known. Some of the best known are iron, aluminum, tin, gold, silver, copper, magnesium, lead, and uranium. But such little-heard-of substances as yttrium, zirconium, palladium, and osmium are metals, too. Mercury is an unusual metal, because it is a liquid. All other metals are solid at room temperatures.

Many of the metals we use are not single metals. They are alloys, or mixtures, instead. Three common alloys are bronze, brass, and steel. Bronze is a mixture of copper and tin, brass of copper and zinc. Steel is a mixture of iron and carbon; but other metals such as chromium, tungsten, and nickel may be added.

Most of the familiar metals have a silvery color. Two exceptions are copper, which has a reddish color, and gold, which is yellow. All metals have shiny surfaces when they are clean. Most metals, however, do not stay shiny and clean for long when they are exposed to the air. They rust or tarnish unless we polish them often.

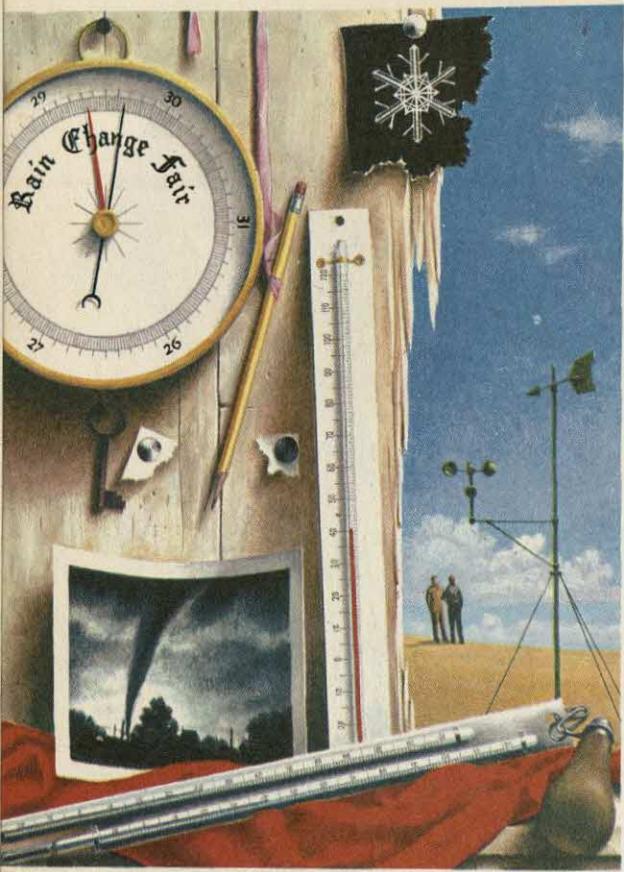
Platinum and gold are two metals that do not have to be polished often. For they

do not tarnish easily. When metals tarnish, they join with elements such as oxygen or sulfur that are in the air. The substances formed then cover the metals. When we polish the metals we rub the covering off.

Gold, platinum, and some other metals are sometimes found free in the earth. We need simply to dig them up and wash away the soil that clings to them. But many metals never exist free. They are found in rocks called ores. Before they can be used they must be taken out of their ores. Fire plays a very important part in getting most metals from their ores.

Metals can be shaped in many ways. They can be melted and poured in molds. They can be rolled out into thin sheets or drawn into fine wires. They can be pounded into the shape wanted. All metals conduct heat and electricity, although some are better conductors than others.

Metals are so useful that some people spend their whole lives studying them. They try to find better and cheaper ways to separate metals from their ores. They try to find better ways of protecting metals from tarnishing. And they try to make better alloys. The study of metals is a science called metallurgy. (See ALLOYS; ELEMENTS; MINES AND MINING.)



METEOROLOGY From its name one might guess that meteorology is the study of meteors. But it is not. Instead, it is the study of the weather.

Meteorology is not a very old science. People studied the stars, which are billions of miles away, long before they thought of trying to find out why the weather around them changes.

Meteorologists now know a great deal about the causes of weather changes. And with the help of radio and radar, weather satellites, and computers, they have become better and better able to predict the weather ahead. They can warn us of coming storms. They have even made a small start in bringing about changes in the weather; they have succeeded in making some clouds drop their rain. In time they may be able to break up hurricanes and keep heavy snowstorms away from big cities. (See U.S. WEATHER BUREAU; WEATHER.)

METEORS AND METEORITES Every few months newspapers tell their readers to watch the sky for a big shower of meteors. Meteors by the billions travel around the sun. They are chunks of rock or iron which, as a rule, are no bigger than peas. The earth on its travels comes close to many meteors. The earth's gravity pulls them in. They glow white-hot as they fall through the air. Most of them are changed to vapor or dust on their way to the ground. People call these meteors that flash through the air and are destroyed shooting stars, or falling stars.

Meteors are not scattered evenly in the space around the sun. Instead, there are great swarms of meteors. The big showers of shooting stars come when the earth runs into one or another of these swarms.

Shooting stars puzzled the people of long ago. An old Egyptian record tells about a night when the stars all jumped about like grasshoppers. Of course, the true stars were not jumping about. There were simply a great many shooting stars that night. The Romans believed that a shower of shooting stars meant that their gods were angry.

There are millions of shooting stars every year. Although there are more of them at some times of the year than at others, one



is likely to see a shooting star or two on any clear night. The dust from shooting stars is making the earth a tiny, tiny bit bigger every year.

It is fortunate that we have the air to protect us from these small meteors. As they enter the air they are traveling very fast. Being hit by one would be like being hit by a machine-gun bullet.

Some meteors that fall from the sky are not completely destroyed during their journey through the air. They are too big. On their journey through the air they are called fireballs. After they hit the earth they are called meteorites.

Fortunately, there are not many fireballs. Fortunately, too, many of them fall in the sea. On land, if they were common, they could do a great deal of damage. In Arizona there is a huge hollow, or crater, which scientists think was made by a fireball or a group of fireballs. On June 30, 1908, a big meteorite landed in a forest in Russia and knocked down all the trees for 20 miles around. There is an old Chinese record telling of a fireball that killed 10 men. But there is no record of anyone's being hit by a fireball in modern times.

There are many meteorites in museums. The biggest one now in a museum was

This huge meteorite, found in Greenland by Peary, is called the Ahnighito meteorite.



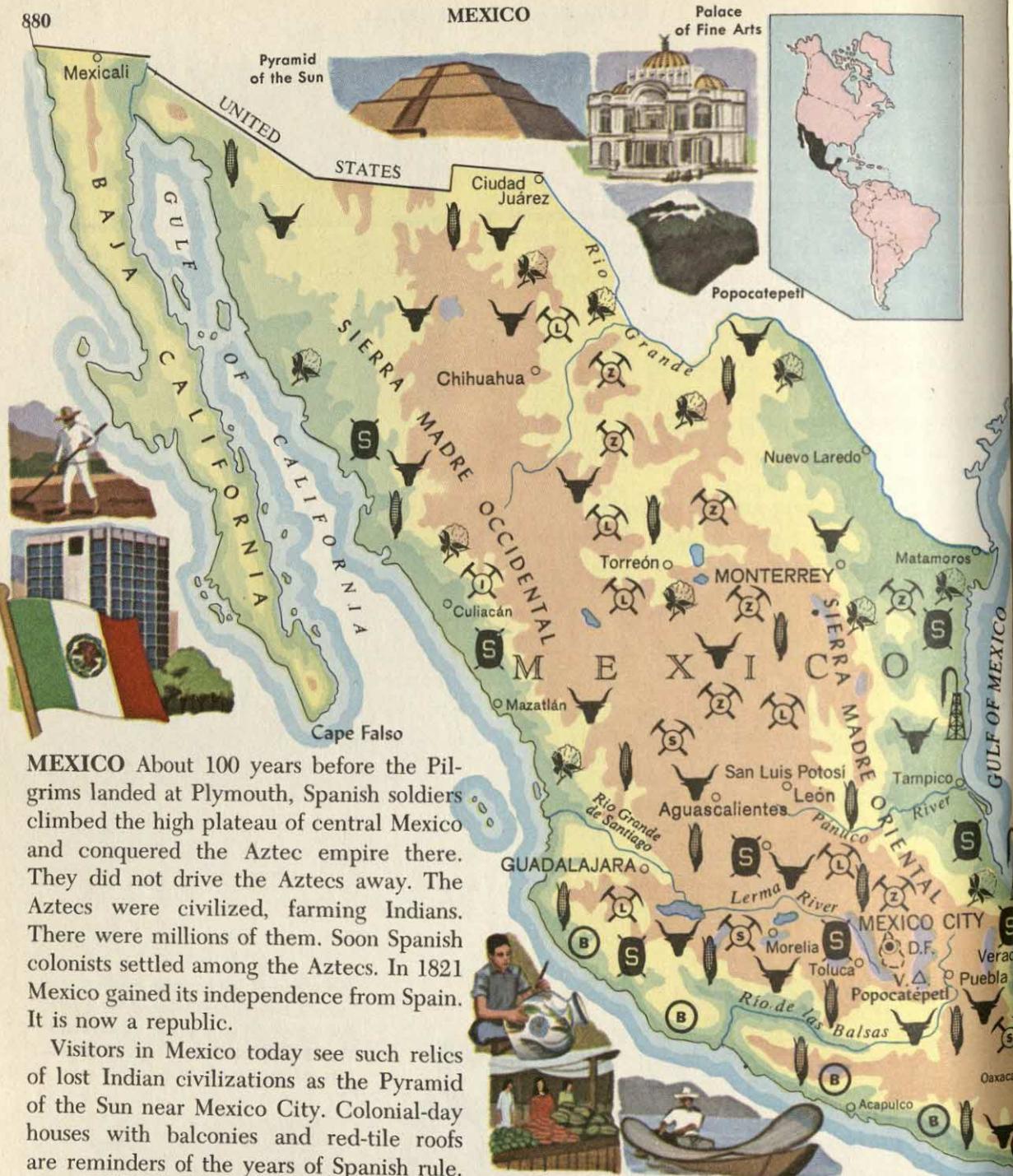
found lying on the ice in the Far North. It was found by Peary, the explorer who first reached the North Pole. This big meteorite weighs $36\frac{1}{2}$ tons.

Some meteorites are made of stone. Others are made of iron. Probably the first iron people used came from meteorites.

Scientists think that the big swarms of meteors come from broken-up comets. They follow paths just like the paths of comets. When a comet does not show up on schedule the earth is likely to have a shower of meteors instead. Where the meteors that are not in the swarms come from is still a puzzle. (See ASTRONOMY; COMET; SOLAR SYSTEM.)

This crater in Arizona is nearly a mile wide. It was formed long ago by a fireball or a group of fireballs that hit the earth and exploded into tens of thousands of pieces.





MEXICO About 100 years before the Pilgrims landed at Plymouth, Spanish soldiers climbed the high plateau of central Mexico and conquered the Aztec empire there. They did not drive the Aztecs away. The Aztecs were civilized, farming Indians. There were millions of them. Soon Spanish colonists settled among the Aztecs. In 1821 Mexico gained its independence from Spain. It is now a republic.

Visitors in Mexico today see such relics of lost Indian civilizations as the Pyramid of the Sun near Mexico City. Colonial-day houses with balconies and red-tile roofs are reminders of the years of Spanish rule.

Northern Mexico is mostly plateau and looks much like southwestern United States. It has deserts and dry grasslands with irrigated fields where farmers grow corn, beans, and squash for family use, winter vegetables for shipping to the United States, and cotton. On the grasslands Mexican cowboys herd beef cattle. Silver, zinc, copper, lead, iron, and other metals are

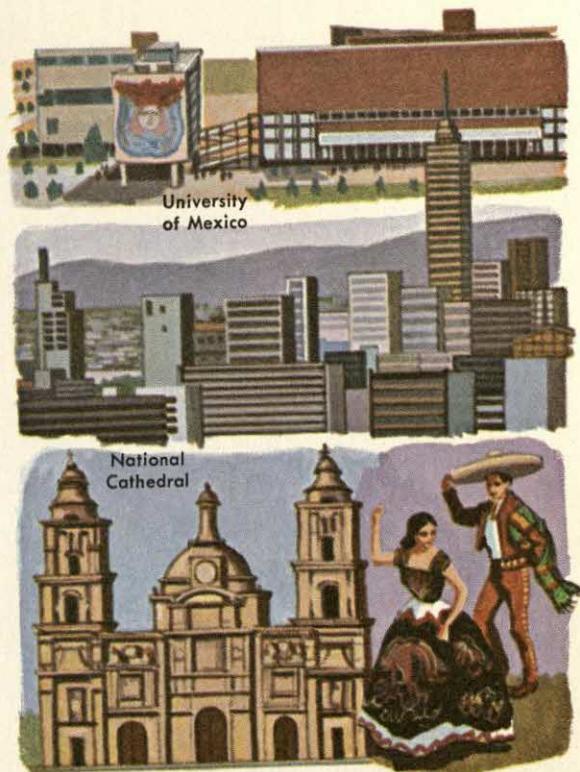
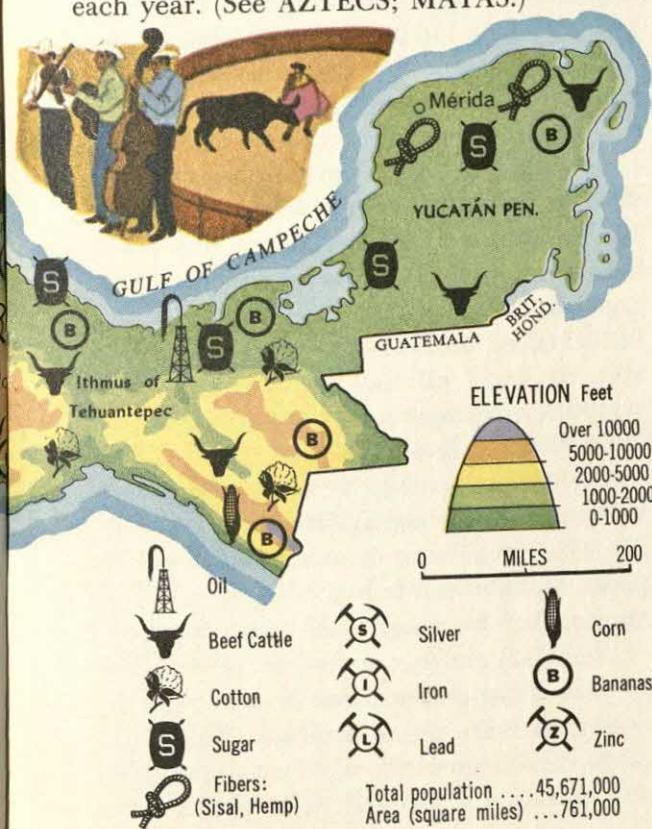
mined. Mexico ranks very high in silver. Monterrey is a big steel-mill city.

The cool, dry central plateau is the heart of Mexico. Two high volcanoes, Popocatepetl and Ixtacahuatl, tower over the region. Half the people of Mexico live on this plateau, many of them in cities. Mexico City, the country's handsome capital, is here. So are Guadalajara and Puebla, both

manufacturing centers. Manufacturing has increased greatly in Mexico in recent years. Cotton textiles rank first among factory products. Other products are flour, sugar, fertilizers, farm machinery, tin cans, and paints. In the towns silver jewelry, baskets, and pottery are made in small workshops. Between the towns there are big stretches of farmland. By far the leading crop is corn. Meat ranks high, too. There are opal and silver mines.

On the slopes from the plateau down toward the Gulf of Mexico there is a mild, lovely region of coffee plantations and citrus orchards. The hot, rainy coastal lowland has forests that furnish fine woods and also chicle for chewing gum. Sugarcane and bananas are grown. And on this lowland Mexico has a big oil field.

The lowlands along the Pacific help furnish the sugar that is one of Mexico's important exports. Cotton cloth, coffee, shrimps, and zinc are among other exports that bring many millions of dollars to Mexico each year. (See AZTECS; MAYAS.)



MEXICO CITY The official name of the capital of Mexico is México, D.F. (D.F. stands for Federal District.) The city can trace its history back to more than a century before Columbus. For the city of today is built on the ruins of Tenochtitlán, the capital of the empire of the Aztecs.

The place where the Aztecs settled and built their capital city was an island in a lake. The site is a wonderful one. It is on a high plateau a mile and a half above sea level. Mountains surround it. Even though the region is at the edge of the tropics, it is so high that the climate is pleasantly warm, not hot.

In their city in a lake the Aztecs had canals for streets. Gleaming white buildings beside the canals made a beautiful city. Cortés, the Spanish explorer who conquered Mexico, called it the most beautiful city in the world. But its beauty did not keep him from destroying most of it. Today's city is beautiful, too. It does not, however, have canals for streets. The nearby lakeland has largely been drained. Streets are paved as in most big cities.

Since it is the capital of the country, many government workers live there. Besides, it is a great trading center. Half of all the people of Mexico live within a fairly short distance. The neighboring region is good farmland. The city's hundreds of factories give work to many. The factories make such varied things as cloth, pottery, glassware, paper, cigars and cigarettes, furniture, chemicals, and silver jewelry. There are iron and steel works, too, and many assembly plants for automobiles and electrical appliances. Tourists have also helped the city grow.

Many of the homes, hotels, shops, and office buildings of Mexico are as modern as any to be found in any country. The University of Mexico has some magnificent buildings with a look all their own. The Palace of Fine Arts contains an excellent art museum and a theater. The Aztec Stadium and other sports arenas where events of the 1968 Olympics took place are among the finest in the world.

Along with the new there is much that is old. At one remaining nearby lake are the floating gardens of Xochimilco, where vegetables and flowers are raised just the way the ancient Aztecs grew their corn and beans. Some of the streets are lined by giant cypress trees the Aztecs planted. In the heart of the city is the National Cathedral, the oldest Christian church in North America. It was built by the Spaniards. The old castle of Chapultepec, high on a hill, overlooks the city. And not far from the city's outskirts are pyramids built by the ancient Toltecs.

Open markets help make the city gay. There are flower markets and vegetable markets with strings of bright peppers and gourds and baskets of vegetables. Gay costumes add to the color.

It is easy for tourists to get to Mexico City. It is a railroad center. Many airlines fly planes to its airport. And good highways now reach it from both north and south. (See AZTECS; CITIES; CORTÉS.)

MICHELANGELO (1475-1564) The ceiling of the Sistine Chapel in Rome is one of the many wonders of art. The whole space—10,000 square feet in all—is covered with marvelous paintings. There are 343 figures, most of them two or three times life-size. And they were done by an artist who said he was a sculptor, not a painter! The artist was the great Michelangelo.

Michelangelo Buonarroti was born near the village of Caprese in Italy. His father was very proud of belonging to one of the oldest families of Florence—so proud that he did not want to work. He wished young Michelangelo could become a scholar and do honor to the family. But the boy was interested only in sculpture. He knew, however, that he could never be a great sculptor without knowing how to draw.

When he was 13 Michelangelo entered the workshop of the painter of Ghirlandajo in Florence. In those days it was the custom for art students to begin their training by copying the work of great artists. Michelangelo went with other boys to copy the paintings in a chapel. He made fun of the work of some of the other boys. One of them in a fit of anger broke Michelangelo's nose. It remained crooked all his life.

In Florence, Michelangelo had a great stroke of luck. The ruler of the city was Lorenzo the Magnificent. He was very much interested in art. He offered the use of his gardens to the most promising art students in Florence. Michelangelo was one. He was able to study all the beautiful pieces of sculpture in the gardens. For a few years he lived in the palace itself.

Michelangelo never found it easy to get along with other people. He led a troubled life. His story is one of many quarrels with popes and rulers. He made a great deal of money, but he spent it all on his family.

Michelangelo was wrong in saying that he was not a painter. But he was right in saying that he was a sculptor. There has never been a greater one. He was an architect and an engineer, too. He designed the

dome of St. Peter's in Rome. And at one time he was the chief engineer of all the defenses of Florence.

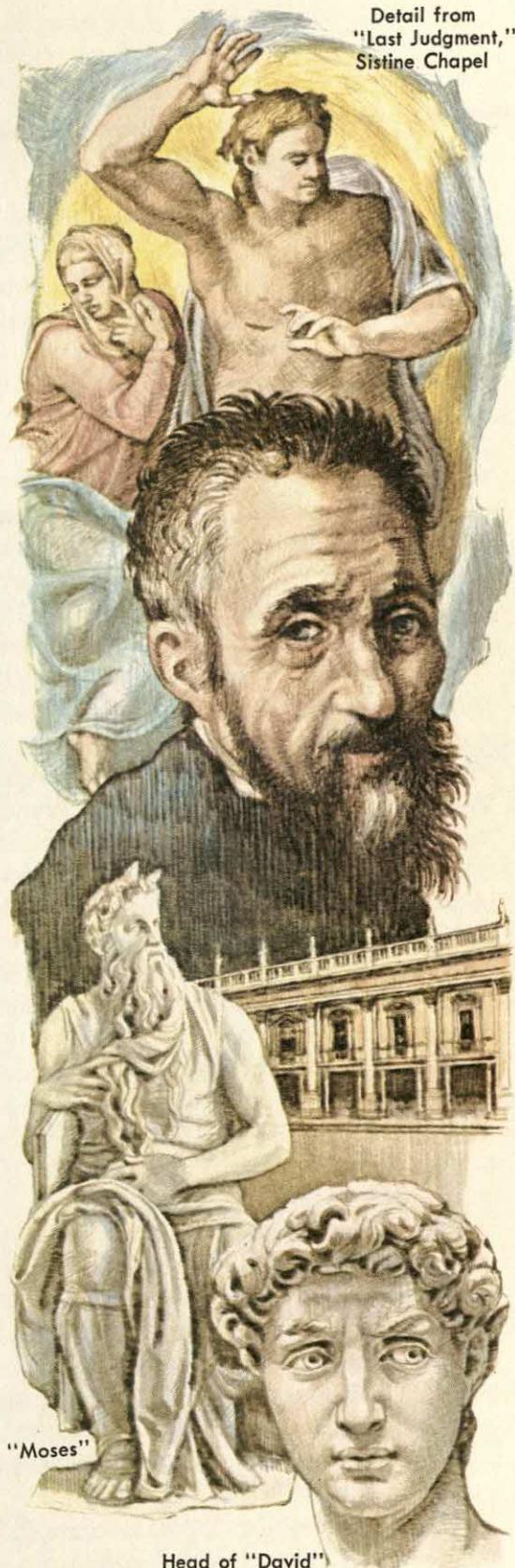
Michelangelo made himself famous as a sculptor by his "David." A great block of marble had stood in Florence for a century. Another sculptor had abandoned it. But Michelangelo looked at it and imagined a giant figure filling the whole block. From the block he carved the statue of David. To show that he had used it all, Michelangelo left a bit of rough stone on the top of the statue's head.

When the pope asked Michelangelo to paint the ceiling of the Sistine Chapel, the artist refused. He did not wish to spend his time painting. But the pope insisted, and Michelangelo at last agreed. For four years he worked on the ceiling. He had to either lie flat on his back on a high scaffold or sit with his neck bent far backward. In summer the air near the ceiling was terrifically hot; in winter it was freezing cold. But the artist worked hour after hour. When the pope told him to hurry he even moved his bed into the chapel.

Some artists of the day had as many as 50 assistants to help them. Michelangelo could not work with assistants. He felt that he must do all the painting himself.

This great artist was a true genius. When people look at his great paintings and sculptures they are speechless. His work has great power. He stands, many writers say, so far above most artists that he is like a mountain above a plain.

Michelangelo's life except for his years in the palace was always hard. Raphael, who lived and worked at the same time, lived like a prince. Michelangelo lived without even ordinary comforts. But he lived to be almost 90. When he knew that his life was nearly over he was sad because he had to leave so much work undone. He had not finished a tenth of what he had dreamed of doing! This great artist died the year Shakespeare was born. (See PAINTERS AND PAINTINGS; SCULPTURE.)



Detail from
"Last Judgment,"
Sistine Chapel

Head of "David"

MICHIGAN The state of Michigan lies in the heart of the Great Lakes country. Its lakeshores border upon four of the five lakes. The name Michigan comes from two Indian words meaning "great lake." Unlike any other state, Michigan is made up of two peninsulas. They are separated from each other by the Straits of Mackinac. The five-mile-long Mackinac Bridge now spans this waterway and connects Mackinaw City with St. Ignace. This bridge is one of the world's longest suspension bridges.

The state motto says, "If you seek a pleasant peninsula, look around you." Every summer the beaches, inland lakes, and forests of these peninsulas attract thousands of vacationers. The northern peninsula with its ski jumps and its heavy snows is popular for winter sports. Isle Royale in Lake Superior is a national park.

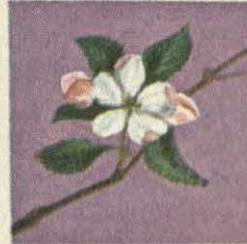
The settlement of Michigan and its growth as a state are connected in many ways with its location on the lakes and with its wealth of minerals and forests. Three hundred or more years ago, French fur trappers, traders, and missionaries arrived in the Michigan forests. They had come westward up the lakes in their birch-bark canoes. They founded the town of Sault Ste. Marie in 1668, the fort of St. Ignace in 1671, and Detroit in 1701. After steamboat travel on the lakes began in the early 1800's, many pioneers from the eastern states came to settle in Michigan. In 1837 Michigan became the 26th state in the Union. It ranks 23rd in area and 7th in population. Lansing is the capital.

Most of the early settlers, at least in the Lower Peninsula, were farmers. Mixed farming is still important on the gently rolling plains there. Much cereal grain from this area is made into breakfast foods at Battle Creek. Truck farms grow vegetables for the cities. An important fruitgrowing belt extends along the eastern shore of Lake Michigan.

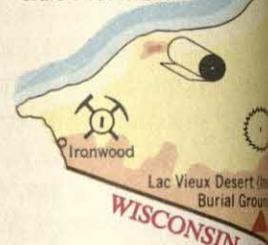
Soon after Michigan became a state, the people turned their attention to their great



State Flower: Apple Blossom



State Bird: Robin



forests and mineral deposits. Between 1840 and 1890, Michigan had business booms in lumbering, in copper mining, and in iron mining. Each boom placed Michigan first in production for a time. The Upper Peninsula is still copper- and iron-mining country. Limestone, found throughout Michigan, is quarried for the state's big cement mills. For many years Michigan has ranked high in salt production. Lands once cleared of their trees are being reforested.

During the lumber boom, Grand Rapids became noted for its furniture manufacture. Many towns in southeastern Michigan built carriages and boat engines. In the early 1900's these industries helped to start Michigan's biggest boom, the auto industry. They furnished many of the skilled mechanics needed. Today Detroit and other former carriage-making cities nearby in Michigan, Indiana, and Ohio form the greatest auto-manufacturing district in the world. Michigan ranks first in automobile production and is a top-ranking manufacturing state. Detroit, one of the country's six cities of more than a million, Grand Rapids, Flint, Dearborn, and Lansing are among the cities that carry on factory work of many kinds.

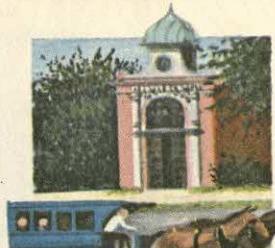
Michigan is nicknamed the "Wolverine State." The white pine is the state tree. The state song is "Michigan, My Michigan."



Early Automobile



Fortress, Mackinac Island



Greenfield Village



Mackinac Bridge



Total state population 8,374,000
Area (square miles) 58,216



MICROFILM The people of today cover many millions of pages with writing and printing. Storing all the important things that are written is a big problem. Now we have found a way of storing a great deal in a small space. We use microfilm. "Microfilm" means "little film."

Pictures are taken on rolls of film. Every page in a big 500-page book can be pictured on a small roll no bigger than a spool of thread. A whole newspaper can be pictured on just a short strip of film.

Of course, the pictures are tiny. No one could read a microfilm with his eyes alone. The films are read with the help of a special kind of projector.

Microfilms save a great deal of space. They are also much easier to send from place to place than books or magazines or newspapers. Microfilms are coming to be an important part of every large library. Banks and government offices use microfilm to keep records. The United States Census Bureau is a big user of microfilm.

MICROSCOPE Looking through a good microscope is like seeing a world of wonders through a magic tube. It is a world of tiny things, some far too small for us to see with our eyes alone. They may be whole plants of interesting shapes and colors. They may be little animals that move fast as we watch them. They may be parts of larger plants and animals—pollen grains from a lily, scales from a butterfly's wing, or red cells from a person's blood. Of course, the tiny things we are looking at may not be

alive. They may be, for instance, crystals of salt or little particles of clay. "Microscope" comes from the Greek words for "see" and "small."

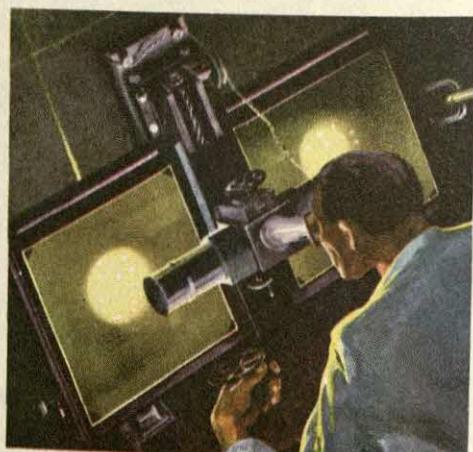
The microscopes most used are light microscopes with lenses through which the light passes. The lenses make what we see through them look bigger—they magnify. The very simplest microscope has only one lens. But most people, when they talk about a microscope, mean a compound microscope. A compound microscope has at least two sets of lenses.

The student microscope in the picture on the next page has just two sets of lenses. One set is in the eyepiece. The other set of lenses is in the objective.

In the stage, or platform, of the microscope there is a round hole. The electric lamp just underneath it sends up light through the hole.

Suppose a person wishes to look at some pollen grains with such a microscope. He first puts a few of the pollen grains on a strip of clear glass called a microscope slide. He then puts a drop of water on the pollen grains, covers them with a very thin piece of glass or plastic called a cover glass, and presses it down. Care must be taken not to trap any air bubbles under the glass. A little air bubble magnified looks like a black ball.

The slide is now put on the stage of the microscope, with the pollen grains over



Astronomer Using Blink Microscope

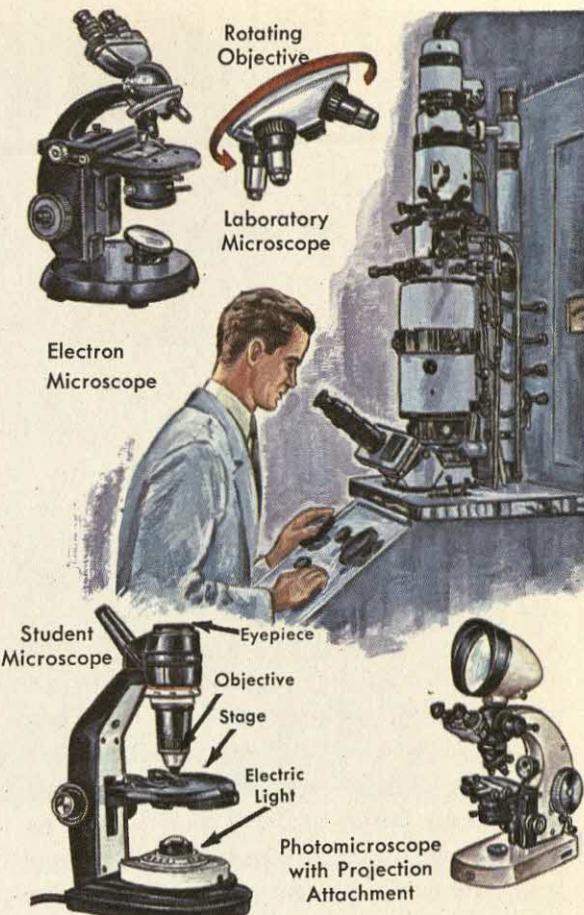
the hole in the stage. Light comes up through the slide and through the microscope tube and lenses to the person's eye. The objective can be moved up and down until the pollen grains show clearly. The moving is done with little wheels. Getting the lenses into just the right position is called focusing the microscope.

The laboratory microscope pictured has three objectives. Of course only one can be used at a time. The magnifying power of the different objectives is different. This microscope also has two eyepieces so that the user can use both eyes to see what he is looking at. It has a mirror for sending light up through the slides and a condenser for regulating the light. With the best compound microscopes a tiny object can be magnified until its diameter looks 2,000 times its real length.

Anton van Leeuwenhoek, who lived in Holland 300 years ago, was the first person to see bacteria with a microscope. He was the first to realize that the microscope would open up a new world that had been invisible before. But he was not the inventor of the compound microscope. Perhaps Zacharias Janssen, a Dutch spectacle-maker, was the inventor. At least he gave a compound microscope to the archduke of Austria in 1590. This microscope was six feet long and was very clumsy.

Not all slides are like the pollen slide. Such a slide would be useful for only a little while; it would soon get dry. Slides can be made that will last for years. They are called permanent slides. The materials to be mounted are often stained so that they will be easier to see. The water is taken out of them in a special way. They are mounted in a resin that becomes hard. Of course, living things cannot be kept alive in permanent slides.

There are other kinds of microscopes. The blink microscope is used by astronomers. With it they study photographs of stars. The planet Pluto was discovered with the help of this special kind of microscope.



With a photomicroscope pictures can be taken of a specimen being studied.

In addition to light microscopes there are electron microscopes. In them streams of electrons are shot past the tiny things to be examined. The electrons make a picture on a special screen. It is a much magnified picture because of the way in which the streams of electrons are bent.

With an electron microscope it is possible to magnify a tiny object more than 100,000 times. The electron microscope brings into view objects less than a millionth of an inch across. With it even molecules of some substances can be seen.

Microscopes are enormously important. They have helped greatly in science and medicine. If the microscope had never been invented, we would know much less than we do about ourselves and the world around us. (See LEEUWENHOEK; LENS.)



MIDAS The story of Midas is a Greek myth. Midas, the story tells, was a king in Asia Minor. He loved gold more than anything else. When the god Dionysus offered to grant him a wish, Midas wished that everything he touched might turn to gold.

The wish was a very foolish one, as Midas soon found out. His food turned to gold as soon as it touched his lips. To keep from starving he had to beg Dionysus to take away his golden touch.

The god told Midas to bathe in the river Pactolus. Midas did. And that is how, the Greeks said, there came to be such a vast amount of gold in the sand of this stream. It was this gold that made Croesus, the famous king of Lydia, very rich. (See CROESUS; MYTHS AND LEGENDS.)

MIDDLE AGES It was about 1,000 years from the fall of the great Roman Empire to the discovery of the New World by Columbus. This time is called the Middle Ages. In talking about the Middle Ages the word medieval is often used. "Medieval" means "of the middle ages."

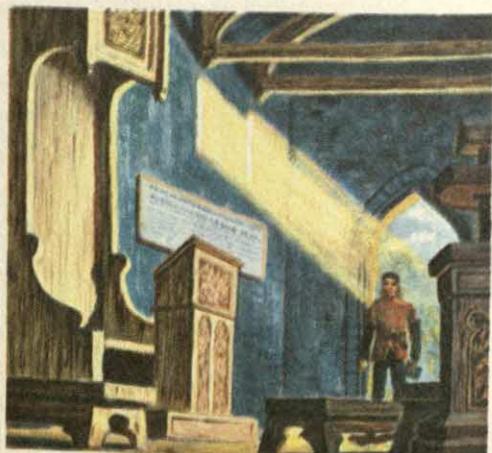
During the first few centuries of the Middle Ages there was great confusion in Europe. The barbarians that had brought about the downfall of Rome plundered the cities and let the roads that tied the Empire together fall into ruins. They cared

nothing for learning. The time is called the Dark Ages. But at last order began to come out of the confusion.

The Middle Ages have sometimes been called the Age of Faith. Even in the darkest days of the Middle Ages the Christian Church in Europe kept alive the learning of the past and the hope for a better world. Many people of the Middle Ages put their religion far above their own comfort. In this time the great Gothic cathedrals were built. In this time, too, the wars called the Crusades were fought to take the Holy Land away from the Moslems.

A way of living called feudalism grew up out of the confusion of the Dark Ages. It helped the people climb out of the sad state into which they had fallen. The common people attached themselves to lords who lived in great castles. Many of the common people were almost slaves; they were called serfs. They worked small plots of land but had to give much of what they raised to their lords. And they could not leave their lords. But in return they were protected. Their lord's castle was a fortress. The common people could not be seized and carried off in chains as they had been earlier. Although their houses were hovels and their food was poor, they were almost sure to have shelter and enough food to keep them alive.

The days of feudalism were also the days of chivalry. Knights swore to speak the



Medieval Classroom



truth always, to fight for the right, to defend the church, to uphold the honor of their lords, and to protect the poor and weak. We get some of our ideas of a true gentleman from the medieval knights.

Feudalism was better than the lack of law and order that had gone before it, but of course it was not good for people to be serfs. Rather late in the Middle Ages most serfs won their freedom. Strong nations were formed, new laws were made, and courts were set up. In many parts of Europe people won the right of trial by jury and other rights that kept them from being treated unfairly. The people of some cities came to be free to rule themselves.

Trade grew. Great fairs were a help. Guilds of workers were formed. Merchants from Genoa, Venice, Lisbon, and Cadiz were finding new routes to the lands of silk and spices in the Far East.

Along with the building of the great cathedrals other arts made progress. Beautiful religious music was written, and

troubadours traveled about singing romantic songs to entertain the nobles. Wonderful tapestries were woven for castle walls. Some suits of armor were works of art. Painters and sculptors arose whose art was the forerunner of the superb painting and sculpture of the time called the Renaissance. There was some great writing.

Universities sprang up. Learning moved forward in certain fields, especially in mathematics, medicine, and philosophy.

The Middle Ages was not a time of great inventions. But a few of those that were made were very important. The compass, the clock, eyeglasses, gunpowder, and printing with movable type were among them.

When the Middle Ages began, the common people of Europe could scarcely call their lives their own. When the Middle Ages ended, a new civilization was well on its way. (See ARMOR; CASTLES; CATHEDRALS; CHARLEMAGNE; CRUSADES; DARK AGES; FAIRS; HISTORY; KNIGHTHOOD; MONKS AND MONASTERIES.)



Baby Pigs Getting Milk from Their Mother

MILK Kittens, puppies, baby pigs, and lambs all have milk for food. So do the babies of all other animals that have hair or fur. We ourselves have only milk for food during our first few weeks of life.

All animals with fur are called mammals. Mother mammals manufacture milk for their babies in milk glands in their bodies. Each kind of mammal has milk which is different from that of every other kind of mammal, but the different kinds of milk are a great deal alike. Cow's milk is so much like our own mother's milk that cow's milk can be fed to human babies.

Several animals besides the cow furnish milk which people use for food. Dwellers in the deserts of Asia and Africa use camel's milk. Boys and girls in the mountains of South America drink the milk of the

llama. People of the north use reindeer milk, and in Switzerland and Greece goats furnish most of the milk. The water buffalo, yak, and sheep are other milk animals.

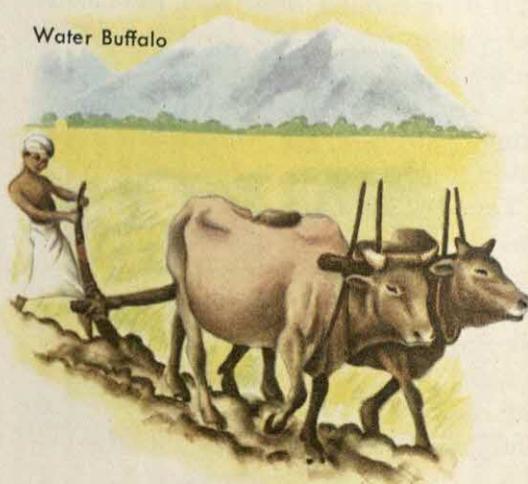
Milk has in it all the things that are necessary in a baby's diet. There are sugar and fat to give heat and energy. There is protein needed for growth. There are minerals to build firm bones and strong teeth. There are also vitamins to make the body work as it should.

Before long, babies need more of some of these things than milk gives them; they must eat other foods. But as they grow up they should keep on drinking milk. One reason is that milk is a better source of calcium than any other food. Calcium is a mineral needed for building strong bones and good teeth and also for making the heart

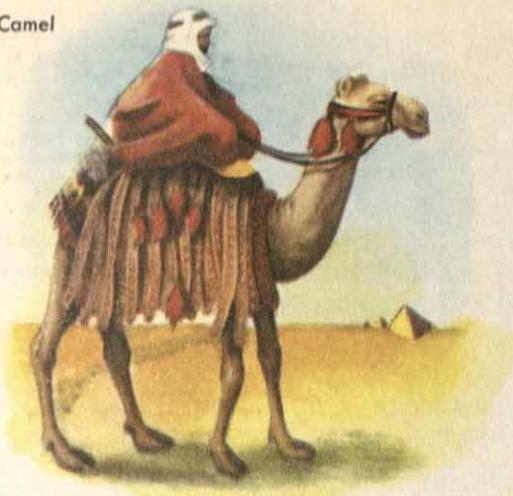
Reindeer



Water Buffalo



Camel

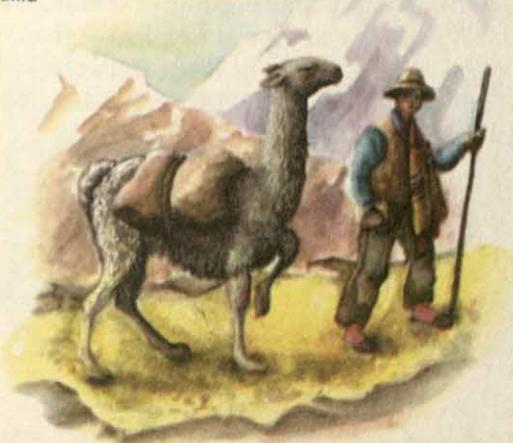


work properly. Even grown-ups need some milk each day, too.

Milk is not only good food itself; other good foods are made of it. Butter is made from the cream, or fat, in milk. Cheese is made from the protein. Ice cream, pudding, cream soups, and many other foods are made with whole milk. A person is able to get at least part of the milk he needs by eating these foods.

The milk we drink and cook with need not be fresh. We can use instead canned milk (either condensed or evaporated) or dried milk. Both canned and dried milk keep for a long time. (See BUTTER; CATTLE; CHEESE; DAIRYING; FOODS; ICE CREAM; PASTEUR, LOUIS.)

Llama



MILKY WAY Our sun is one of the stars in a great star city, or galaxy. There are about 100 billion stars in this galaxy. All the separate stars we see when we look up at the sky are in this great star city.

Our star city is often called the Milky Way Galaxy. It gets its name from the hazy band of light in the night sky called the Milky Way.

The Milky Way can be seen most easily on clear moonless nights in midsummer or midwinter. The Mexicans call it by a name which means "the little white sister of the many-colored rainbow."

The people of long ago made up many stories to explain how this band of light



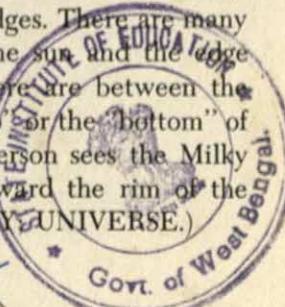
Portion of Milky Way

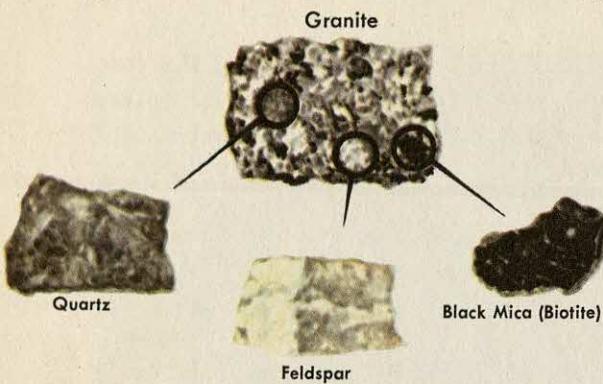
happened to be in the sky. The early Greeks said that it was dust stirred up by the hero Perseus as he rushed across the sky after he had killed Medusa, the terrible Gorgon who had snakes for hair.

Now we know that the Milky Way is starlight. It is light from billions of stars, most of which are too far away to be seen as separate stars.

Our star city is shaped like a bun much flattened around the edges. There are many more stars between the sun and the edge of the "bun" than there are between the sun and either the "top" or the "bottom" of the "bun." When a person sees the Milky Way he is looking toward the rim of the star city. (See GALAXY; UNIVERSE.)

1996 3379





MINERALS Granite is a common rock. It is used in many buildings, especially in monuments, for two reasons. It can be highly polished, and it lasts for a very, very long time. The granite in the picture is speckled. It is made of bits of some dark material, bits of a material that looks like glass, and bits of a light material. The dark material is black mica, the glassy material is quartz, and the light material is feldspar. Black mica, quartz, and feldspar are all minerals. Granite is always made of three minerals—usually these same three. It is always speckled, but the speckles differ in size.

All rocks are made of minerals. A rock may be made of just one mineral. But most kinds of rocks are mixtures of minerals.

The earth is a great treasure-house because of the minerals it has in it. For these minerals give us all our metals and most of our jewels. "Mining" and "minerals" begin with the same syllable. No wonder! For mines are dug to get minerals.

There are about 1,500 minerals scientists know about. About 150 of these are important to us. No one can tell from the look of a mineral how valuable it is. Pyrite looks like gold, but it is worth far less. It is called fool's gold. The corundum pictured is not beautiful, but ruby and sapphire are corundum, too.

The bits of quartz, feldspar, and mica in granite are really crystals. Almost all minerals are sometimes found as crystals. Each mineral has its own crystal shape. In granite the crystals are so crowded together that they are not perfect. The quartz crystals,

for instance, are much smaller and less perfect than the big quartz crystal pictured at the bottom of the page.

Some minerals are much harder than others. It is easy to tell which of two minerals is harder. The harder one will make a scratch on the softer one. Scientists have made a scale that tells how hard a mineral is. This is the hardness scale:

1. Talc	6. Feldspar
2. Gypsum	7. Quartz
3. Calcite	8. Topaz
4. Fluorspar	9. Corundum
5. Apatite	10. Diamond

Talc is the softest of the ten, and diamond the hardest. If a mineral has the hardness of 6.5, it is harder than feldspar but not as hard as quartz. Quartz will scratch it, but it will scratch feldspar.

The commonest of all minerals is quartz. Almost every grain of sand is a tiny, worn crystal of quartz.

Water will dissolve some minerals. Water that we call hard has a great deal of mineral matter dissolved in it. The beautiful stone icicles in caves are made of minerals dissolved by water underground and then left behind when the water dripped into the caves and evaporated.

Soil is made mostly of broken-up rock. Of course, then, it is made mostly of minerals. How good a soil is depends partly on the size of the soil particles. It depends, too, on what chemical elements the minerals have in them. Plants must have certain elements in order to grow, and plants growing in soil must get most of them from the soil. (See CRYSTALS; MINES AND MINING; QUARTZ; ROCKS.)



Smoky Quartz



Corundum



Rhodochrosite



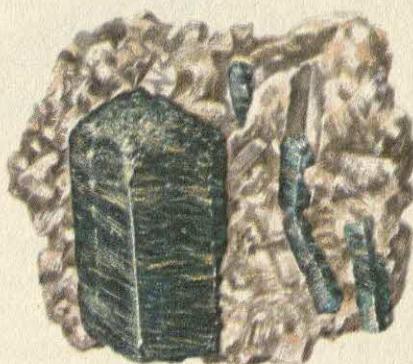
Hornblende

Dogtooth Spar (Calcite)



Galena

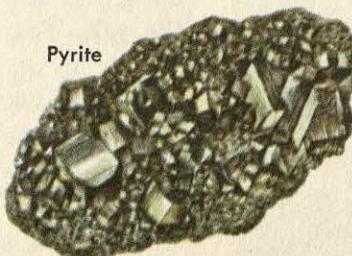
Apatite



Stibnite



Talc

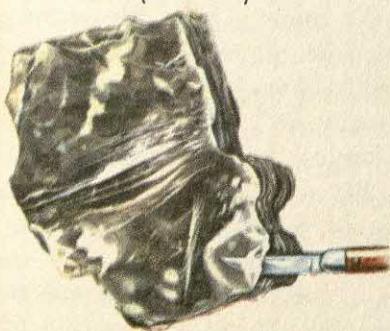


Pyrite

Topaz



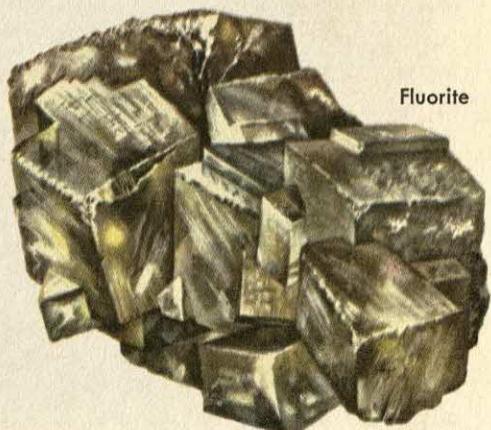
White Mica (Muscovite)



Scheelite



Fluorite





MINES AND MINING The earth is a great storehouse of riches. Valuable minerals of many kinds are found in it. These minerals are taken out of the earth, or mined, in a number of different ways.

How a mineral is mined depends mostly on where in the earth the mineral is found. It may be scattered through loose sand or gravel. It may be in solid layers near the surface or deep underground. It may be found distributed through rocks in streaks called lodes or veins.

Water is a big help in some kinds of mining. Panning, for instance, is one way of mining gold. The miner gathers up a panful of gravel with bits of gold in it. He washes away the gravel till only the gold is left. Gold is much heavier than the other materials in the gravel. The pioneer miners pictured are using a rocker instead of a pan to separate the gold from the gravel.

In hydraulic mining big jets of water are shot at beds of gravel containing the mineral wanted. The mineral is left after

the rest of the gravel is washed away. Tin ores are often mined in this way.

To get salt from layers of rock salt deep below the surface, water may be forced down through pipes. It dissolves some of the salt. Then the water with its salt is forced up again. The water is made to evaporate, and the salt is left.

Sulfur deep underground is mined with very hot water. The hot water is forced down into the layer of sulfur. It makes some of the sulfur melt so that it can be forced up to the surface.

In some cases mining means simply scooping up the mineral from the surface of the ground. Such mining is called open-pit, or opencut, mining. Much copper ore is mined in this way. So is much iron ore.

A similar kind of coal mining is called strip mining. Big shovels scoop off the soil on top of a layer of coal. Then they scoop up the coal that is uncovered.

Sometimes a layer of a mineral comes to the surface on the side of a mountain or

hill. Then tunnels may be dug into it, and it may be hauled out in cars. Some coal is mined in this way.

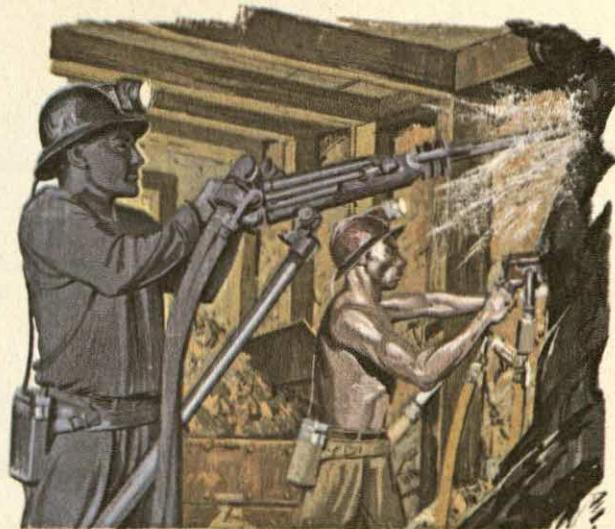
Most of the minerals deep in the earth are mined by means of shaft mines. A shaft is dug down till it reaches the mineral. Then tunnels are dug outward from the bottom of the shaft. A great deal of the world's supply of coal is mined in shaft mines. So is much gold, lead, nickel, and silver. The minerals dug out have to be hoisted up to the top of the ground. A shaft mine may have tunnels going out so far in all directions that they are almost like little cities underground.

Some shaft mines are very deep. Many nickel, diamond, and gold mines are. Some gold mines go to depths of over two miles. Man has never gone deeper into the earth.

Of course, mining deep underground is a dangerous occupation. There is always the risk of cave-ins. There is the danger, too, of poisonous gas. In very deep mines there is also the danger of being overcome by heat. Cooling systems have been put in some of the very deep mines to lessen this danger. Machines now do much of the hard and dangerous work miners used to have to do by hand. Many other steps have been taken to make mining easier and less dangerous than it used to be.

Mining is not at all a new occupation. At least 5,000 years ago the Egyptians were mining copper and turquoise in the Sinai Peninsula across the Red Sea. They mined gold in nearby Nubia. Slaves worked their mines. The early Hittites of Asia Minor had iron mines. The Greeks mined silver and lead. The Phoenicians went all the way to Britain to get tin. Mining probably did not begin with any of these peoples. But it almost certainly began somewhere in the Near East in the days when copper first began to take the place of stone.

Over the centuries some mining has been done wastefully. Great pillars of coal have been left standing to hold up the "roofs" in coal mines. In some ore deposits only the



Underground Mining

best ore has been mined and the mines have been left in such shape that it will never pay to reopen them.

One great deposit after another has been worked out. Even in young America there are ghost mining towns to tell the story of a part of the earth's storehouse that has been emptied. Tombstone, Ariz., and Silver City, Idaho, are two famous ghost towns. (See COAL; CONSERVATION; COPPER; DIAMONDS; GOLD; IRON AND STEEL; METALS; MINERALS; NICKEL; SALT; SILVER; SULFUR; TIN; URANIUM.)

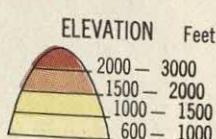
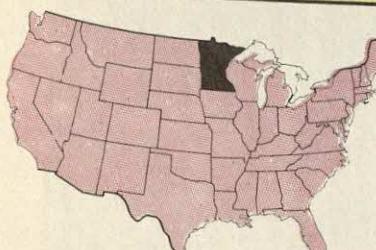
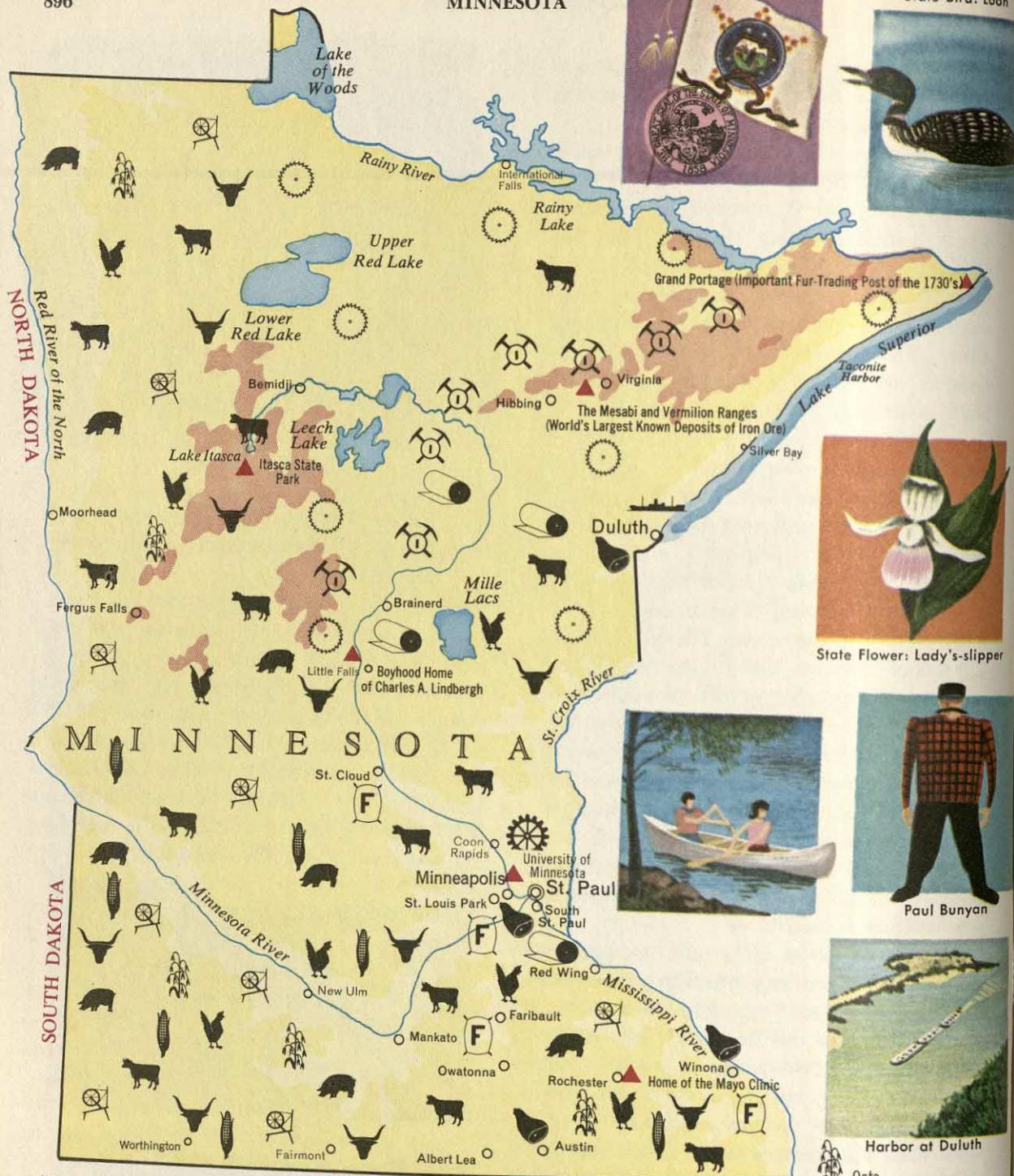


Open-pit Mining



Hydraulic Mining

MINNESOTA



0 MILES 50

Total state population ... 3,576,000
Area (square miles) 84,068

▲ Historical Sites and Points of Interest

Iron	Flax
Hogs	Lumbering
Dairying	Machinery
Beef Cattle	Corn
Poultry	Shipping
Meat Packing	Paper and Pulp

MINNESOTA This large north-central state borders upon Canada. It has a shoreline on Lake Superior. To the Indians of the region the name Minnesota meant "sky-tinted water." There are many small lakes within the state. From one of these, Lake Itasca, rises a narrow stream which becomes the mighty Mississippi. Minnesota's lakes give it one of its nicknames—"Land of 10,000 Lakes." An older nickname—"Gopher State"—was given Minnesota because of the striped ground squirrel, or gopher, so common all over the state.

The first white men to seek a living in the Minnesota country were French and English fur trappers and traders. They were followed by lumberjacks who cut timber from the fine stands of white pine and other conifers. Lumbering boomed in northern Minnesota until early in the 20th century. The legends of Paul Bunyan date from the lumbering days of Minnesota.

About the middle of the 1800's American pioneers came from the east to make their homes in this new area. Some came west through Illinois by railroad and then took northbound Mississippi steamboats to the region. In 1858 it became a state. With the growth of rail lines more settlers poured into Minnesota. Many were newcomers from Norway, Sweden, Denmark, and Finland. They felt at home in this forested region of cold winters. With their hard work and thrifty ways, they helped Minnesota prosper.

Minnesota is one of the leading farm states of the country. It is sometimes called the "Bread and Butter State" because it produces much wheat flour and butter. Minnesota ranks second, next to Iowa, in the percentage of fertile, level land suitable for farms. On its southern prairie lands are many dairy and livestock farms. The products of the dairy farms go to city markets in and out of the state. Stock farms ship livestock to meat-packing plants in South St. Paul, Austin, and Winona. On the nearly level floor of the Red River Valley, in western Minnesota, farmers grow large

crops of wheat, potatoes, and flax. Minneapolis and other cities are important centers for milling flour and for making products of linseed, or flaxseed.

Minnesota has long led in the production of iron ore. Years ago great stores of it were found in the northeastern part of the state very near the surface. Large quantities of iron ore are shipped down the lakes from Duluth to steelmaking centers such as Chicago, Gary, Cleveland, and Erie.

So much of the good ore has now been mined that experts say it may soon be used up. But ways have been worked out of using the low-grade ore called taconite to serve in its place. There is only about half as much iron in taconite as in good ore. To use taconite, the tiny particles containing iron that are scattered in the rock have to be concentrated, or brought together. Plants for crushing taconite and then separating the iron particles and making pellets of them have been built at new ports on Lake Superior. Fortunately, Minnesota has vast amounts of taconite.

Among the things people of Minnesota point to with pride are the famous Mayo Clinic and Mayo Foundation at Rochester, the state university at Minneapolis, and the capitol at St. Paul. Railroads, airlines, and river traffic combine to bring much trade to the "Twin Cities," Minneapolis and St. Paul. Together the Twin Cities have some 800,000 people. Duluth is the state's only other large city.

Every summer the state's woodlands and lakes attract thousands of vacationers. Winter visitors come for skiing, skating, iceboating, and tobogganing.

Minnesota's motto, *L'Étoile du Nord*, is French for "The North Star." It comes from Minnesota's location as the northernmost of the states before the admission of Alaska. The motto gives Minnesota still another of its nicknames—"North Star State." The state tree is the Norway pine. There is no official state song. But the university song, "Hail! Minnesota," serves as one.



Desert Mirage

MIRAGE Sailors have often on their voyages reported seeing land even though their ship was in the middle of the ocean. When they sailed in the direction of this land they saw, it would disappear.

On journeys across deserts travelers have sometimes seen a lake ahead of them. Being very thirsty, they would rush toward it only to find it gone.

On their explorations of arctic regions explorers have seen high mountains just ahead. When they tried to get closer, the mountains were not there.

For a long time no one could explain these strange experiences. Most people probably thought that the travelers were ill and feverish from their long journeys and were simply "seeing things."

In 1798 Gaspard Monge, a friend of Napoleon, finally solved the problem. Monge was a French scientist who was with Napoleon's army in Egypt at the time. The French soldiers were continually reporting seeing water in the desert where there was no water. Monge became interested in this trick of nature.

He decided to call what they saw a mirage from a French word which means "to gaze." The explanation which he worked out is still considered to be the right one.

Mirages are not just imagination. They are reflections of things which actually exist some distance from where the mirages are seen. The "mirrors" which reflect these

scenes are, strangely enough, layers of air. These layers are much hotter or colder than the air just above or below them. The reflected picture is often upside down and out of shape. Reflections of sky look like water. When people on deserts think they see water, they are really seeing reflections of the sky or of water some distance away. When travelers see mountains and shores where there are none they are seeing reflections from afar.

Sometimes layers of hot and cold air are arranged in such a way as to make them act just like a lens. Then objects are magnified and the images in a mirage are much bigger than the actual objects.

Sometimes a mirage is very complicated. Such a mirage is caused by many irregular masses of hot and cold air.

For 400 years people of Reggio di Calabria, in the toe of Italy, have reported from time to time seeing a marvelous castle in Sicily, just across the Strait of Messina. It appears to be half in the air and half under the sea. The castle is called Fata Morgana, after Morgan le Fay, the sister of King Arthur of England. She supposedly had a submarine palace where she took care of Arthur when he was ill. Fata Morgana is a mirage. People are really seeing the complicated reflections of distant cottages. (See LENS; LIGHT; OPTICAL ILLUSIONS.)

MIRROR Probably the first mirror was the surface of a still pond. Our earliest ancestors must have noticed that they could see themselves in still water.

In ancient times mirrors were made of polished metal. The beautiful Queen Cleopatra of Egypt never saw herself in a mirror like those we have now.

A person can see himself in a mirror because the mirror bends back the light that strikes it. We say that it reflects the light. Such things as carpets and painted walls reflect much of the light that falls on them. But the light they reflect is scattered. A

mirror reflects the light without scattering it. To avoid scattering light the surface of a mirror must be very smooth.

Some of the best early glass mirrors were made in Venice in the 16th and 17th centuries. These mirrors of Venetian glass were very expensive. A French court lady once traded a whole farm for a mirror and was pleased with her bargain. Louis XIV, king of France, had a splendid Hall of Mirrors built in his palace at Versailles. Good mirrors did not become common until the 18th century, after plate glass had been invented.

Glass alone does not make a good looking glass. Light goes through it instead of being reflected from it. The back of the glass has to be covered with something that the light cannot go through. Many mirrors used to be coated with mercury. But silver is used most often now.

Some mirrors are curved. A curved mirror may make things look larger than they are. It may make them look smaller. It may make them look longer and slimmer or shorter and fatter. A curved mirror may even make things look upside down. It all depends on how the mirror is curved.

Magicians do some of their tricks by using mirrors. Mirrors are used, too, in microscopes, periscopes, and telescopes. The world's most famous mirror is in a telescope in the observatory on Mount Palomar in California. It is a great curved mirror 200 inches across. (See GLASS; KALEIDOSCOPE; LIGHT; MICROSCOPE; PERISCOPE; TELESCOPE.)

San Xavier
Tucson, Arizona



San Miguel
Santa Fe, New Mexico

MISSIONS Scattered over southwestern United States there are a number of old Spanish missions. They all look much like those in the pictures. These missions were built from 150 to 300 years ago by Roman Catholic priests.

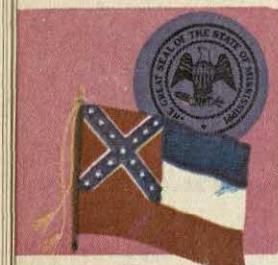
Places for the missions were chosen carefully. They were built in spots with good soil and plenty of water for irrigation. Soon each mission was the center of olive and orange orchards and fields of grain. The buildings had thick adobe walls and small windows. The roofs were of red tile. The buildings suited a hot, dry climate well. Many houses in the Southwest today are built in the same style.

When the missions were founded, there were almost no white settlers in the region. But there were many Indians. The Spanish priests invited the Indians to worship with them. They also taught the Indians how to build better houses, raise better crops, and make shoes and soap. Once in a while at a mission there was a gay fiesta.

The great days of the missions ended in 1822. The region was not yet a part of the United States. The Spanish priests were driven away by the Mexicans. The mission fields, gardens, and buildings were allowed to go to ruin. But some of the buildings still stand. They are being well cared for today. (See ALAMO.)

San Jose de Tumacacori, Arizona





State Bird: Mockingbird

State Flower: Magnolia



Shrimp Boat



Biloxi Lighthouse

0 MILES 25

LOUISIANA

- Cotton
- Beef Cattle
- Dairying
- Oil
- Lumbering
- Paper and Pulp

Chemicals

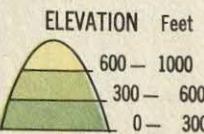
Poultry

Fish

Garden Crops

Tung Nuts

Resorts



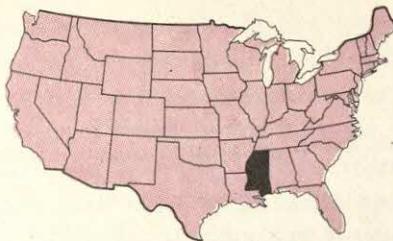
▲ Historical Sites and Points of Interest

Total state population . . . 2,327,000
 Area (square miles) 47,716

First Permanent White Settlement in Mississippi Valley, 1699

Gulfport Biloxi Pascagoula GULF OF MEXICO





MISSISSIPPI This southern state has a short coastline on the Gulf of Mexico. Almost all of its western border is formed by the zigzagging Mississippi River. The state took its name from the river. The name means "Father of Waters."

The first white settlement was made by the French in 1699. It was at what is now Ocean Springs. In 1716 Fort Rosalie, now Natchez, was established. After the Revolutionary War American pioneers arrived from the east and the north. They came overland and by flatboats and steamboats on the Mississippi. Steamboat trade helped to build the river ports of Vicksburg and Natchez.

Settlers found much rich, deep soil in this warm state. With the help of slaves they laid out big plantations close to the Mississippi. They built handsome homes with tall white pillars. Lovely gardens and green shaded lawns surrounded the big houses. Tobacco and indigo were the first plantation money crops. After the cotton gin came into use, cotton was the big money crop. Cotton growing spread into other fertile areas. In 1817 Mississippi became the 20th state in the Union.

Today Mississippi is still a farming state. A fourth of its people live on farms. Some farmers have turned to dairying or cattle raising. Poultry and eggs bring in many millions of dollars a year, too. As the map shows, garden crops are now important in the southern part of the state. But cotton remains the main crop of Mississippi. It is raised on small farms of 30 or 40 acres and on larger plantations of hundreds or even thousands of acres.

Farmers in Mississippi are improving their farms. Tractors have taken the place

of mules. Farm machinery is used to plow and to plant the large, level fields. Some farmers have cotton-picking machines. Some hire men with airplanes to dust poison over the cotton fields to kill the boll weevil, an insect enemy of cotton. Farmers are getting much higher yields than they used to get. In the early 1900's, for instance, cotton growers were getting less than 200 pounds per acre. Now they are getting more than 700. Fewer workers are needed on the farms today, and many young people leave the farms for the cities.

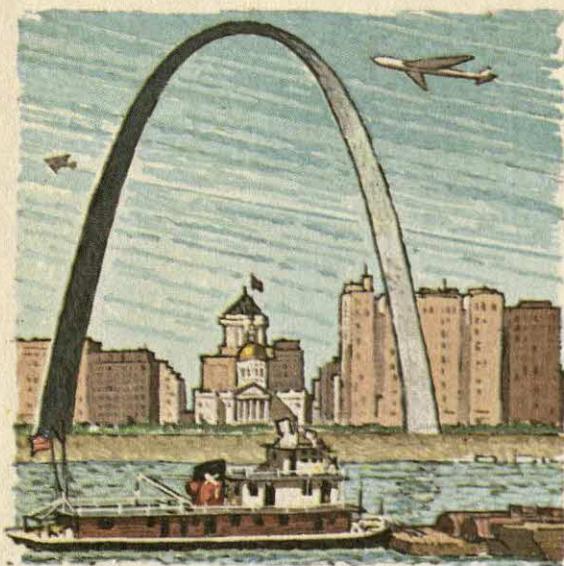
Much lumbering is done in the "piney woods" section of the southern half of the state. The tung tree introduced from China was planted in the region many years ago. Now the nuts of this tree furnish oil for paint and varnish.

Old and new mingle in Mississippi. At Natchez each spring hundreds of visitors enjoy the tours to the beautiful restored homes and gardens of the old plantation days. Women and children wearing costumes greet the visitors and act as their guides. A beautiful broad highway above the seawall along the Gulf leads to Biloxi and Gulfport, two well-known winter resorts. At Biloxi one may hear the shrieking of the whistles of the canneries when the shrimp boats come in. The workers must come to the canneries at once to get the shrimp ready to be shipped, either fresh, frozen, or canned.

Jackson, the capital, Meridian, Biloxi, and some smaller cities have factories using products of the state's farms and forests. Oil wells and oil refineries furnish work for many, too.

Not even the larger cities of Mississippi are very large. Jackson, much the largest, has a population of about 170,000.

The state tree is the magnolia. This beautiful tree is common enough to earn Mississippi its nickname of "Magnolia State." *Virtute et armis*, the state's Latin motto, means "By valor and arms." "Way Down South in Mississippi" is the state song.



"Gateway to the West" Arch, St. Louis

MISSISSIPPI RIVER The great Mississippi River divides the 48-state block of the United States into two parts. It runs from almost as far north as the northern boundary south to the Gulf of Mexico. For almost its whole length, crossing this river means crossing from one state into another. For a time it was the western boundary line of the United States.

The Mississippi is sometimes called the "Father of Waters." Perhaps it was given this name because it is a very large river—more than a mile wide in places. Perhaps it got the name because it has many tributaries, or branches, some of which are great rivers themselves. The chief branches are the Minnesota, the Wisconsin, the Illinois, the Missouri, the Ohio, the Arkansas, and the Red rivers.

The Mississippi and its main branches form a vast inland waterway. This waterway stretches from the Appalachian Mountains to the Rocky Mountains over an area of about 1,250,000 square miles.

The great Mississippi River begins at a little lake in northern Minnesota—Lake Itasca. As it flows out of the lake it is such a small stream that one can actually step across it. It gives no sign of being one of the world's greatest rivers. From Lake Itasca to the Gulf of Mexico the river is about 2,500

miles long. Several other rivers are longer. But in tables of rivers the Mississippi-Missouri is often listed rather than just the Mississippi alone. Figures differ for the exact length of the Mississippi-Missouri. It is certainly one of the three longest of all rivers.

An enormous amount of water pours down the Mississippi to the sea. At times such a great deal of water runs into the river that its banks cannot hold it all. Then there are great floods.

At its mouth the river has built up a large delta. The delta is made of sand and mud carried down by the river. Farmers lose millions and millions of tons of good soil to the river every year.

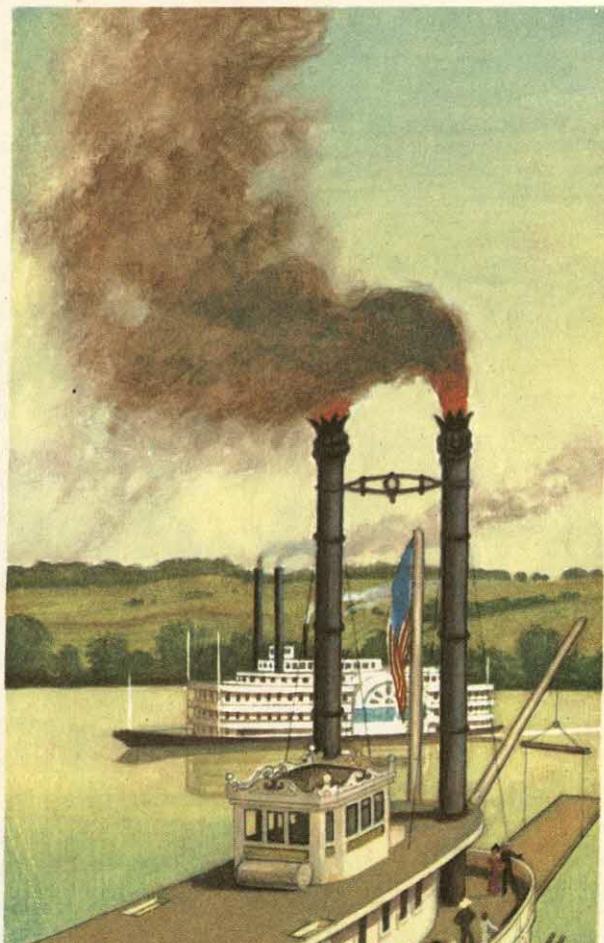
The Mississippi has many mouths. It breaks up into branches as it flows through the delta it has built up. These branches are known as the Passes.

The Spanish explorer De Soto crossed the Mississippi more than 400 years ago—in 1541. But the river was not explored for more than 100 years. Then the famous French explorers Marquette, Joliet, and La Salle traveled along it.

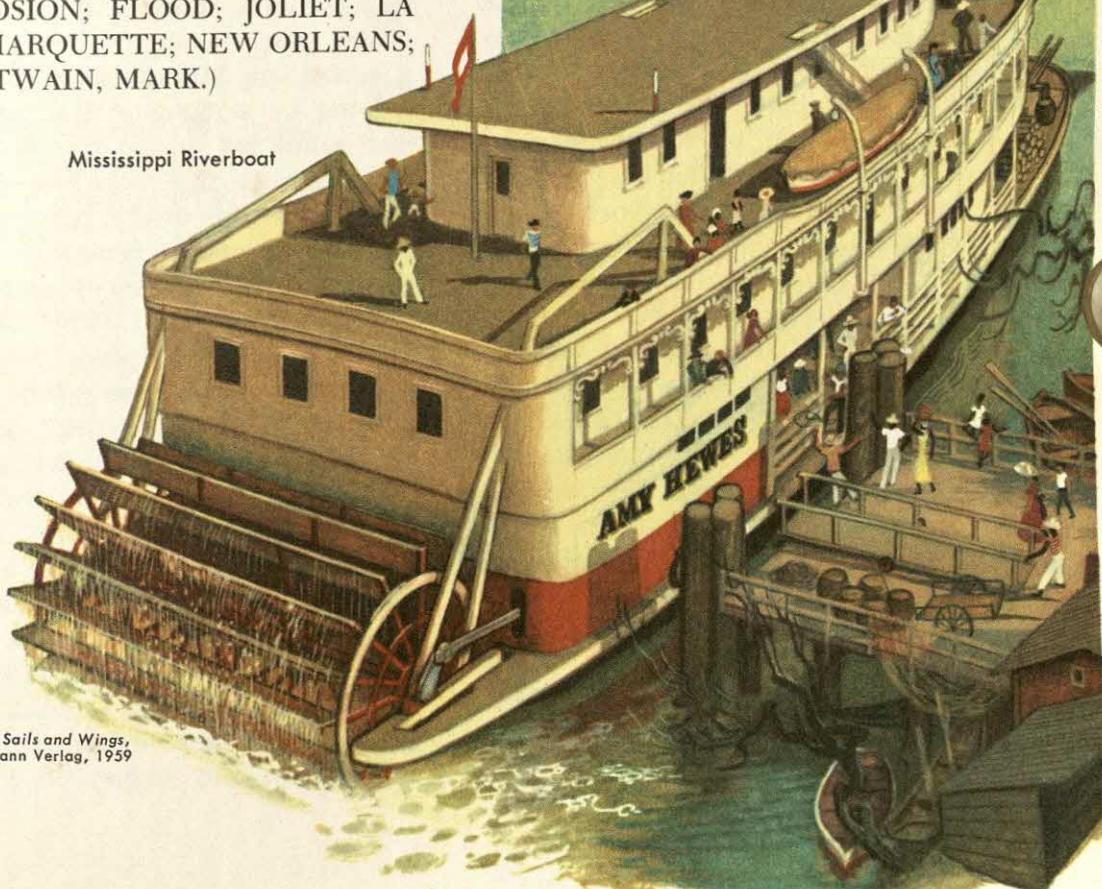


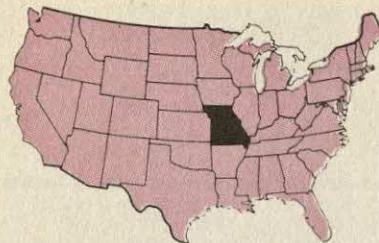
After the steamboat was invented and the lands along the river were settled, the river became a very important highway. Passenger boats carried many people up and down it. Cargoes of cotton, sugar, and molasses from the South and cargoes of corn, wheat, pork, beef, cheese, and potatoes from the North filled hundreds of freight boats. Showboats traveled along the river. The great steamboat days on the Mississippi were from about 1820 to 1870. Several of the cities on the banks of the river grew big. Their wharves were busy places. Busiest among these river cities were New Orleans and St. Louis.

With the coming of the railroads the river lost much of its importance as a highway. But today it is again busy with traffic. Huge barges carry such bulky products as lumber and coal, new cars and petroleum. St. Paul, Minneapolis, Memphis, Baton Rouge, and many smaller cities as well as New Orleans and St. Louis owe their prosperity partly to the Mississippi. (See BIRD MIGRATION; DELTA; DIKES AND LEVEES; EROSION; FLOOD; JOLIET; LA SALLE; MARQUETTE; NEW ORLEANS; RIVERS; TWAIN, MARK.)



Mississippi Riverboat





MISSOURI This state lies in the central part of the Mississippi Valley. The Mississippi River forms its eastern border. The Missouri River crosses the state to join the Mississippi just above the big city of St. Louis. Missouri was the name of an Indian tribe and is said to mean "people of the big canoes." The state has given the nation many famous people, among them the river pilot and author Mark Twain, the poets Eugene Field, Marianne Moore, and T. S. Eliot, and the great Negro scientist George Washington Carver. Harry S. Truman was born in Missouri, and a log cabin built by Ulysses S. Grant still stands near St. Louis.

Names such as St. Louis, Cape Girardeau, and Ste. Genevieve are reminders of the early French settlement of the region. Among the Missouri pioneers from eastern states were Daniel Boone and his sons. In the 1800's Missouri was the taking-off place for fur traders, and for families in covered wagons bound for the Far West. It was the starting point of the Santa Fe Trail, the Oregon Trail, and the Pony Express. The 630-foot-tall Gateway Arch in St. Louis is a fitting monument for a Missouri city.

Many pioneers who reached Missouri on their way westward remained to farm and to build cities. They found the mild Missouri climate and the fertile soils of the nearly level prairie land in the northern half of the territory good for grain and livestock farming.

Some settlers came from the Old South, bringing their slaves, to grow tobacco and cotton. Settlers from north of the Ohio River worked their own farms. People from eastern Kentucky and Tennessee built log cabins in the lonely Ozark highlands in

southern Missouri and raised patches of corn to feed a hog or two. In some ways Missouri was like the North and in others like the South. In 1821 it became the 24th state in the Union. It ranks 19th in area and is now 13th in population. The capital is Jefferson City.

Today Missouri is one of the rich farm states. More than half the state is covered with pastures and fields of crops. Farmers earn most from their cattle, hogs, soybeans, and dairy cows. In the days when mules were important farm animals in this country, Missouri was famous for its mules. Mules are not much in demand now, but Missouri's saddle horses are sold throughout the United States.

Many changes have come to the Ozarks. New highways, new schools, radios, and television acquaint the mountain farmers with other people. The lakes, woods, and swift streams of the Ozarks help make it a good vacationland. Missouri is proud of its fine hunting and fishing. It is proud of its many state parks, too. One, Big Springs, has a spring with a flow of 600 million gallons a day.

In southern Missouri many people earn a living by working in lead mines. Missouri ranks first among the states in lead production. It also ranks first in the production of barite, used in paper and rubber products. Silver, too, is mined.

Missouri also has many manufacturing plants. Its farms and mines furnish raw materials and coal for power. Meat packing and making foods from grains are giant industries. Kansas City, Mo., and Kansas City, Kan., form a great trade and manufacturing center for farm products. The manufacture of transportation equipment earns even more money for the state. Boots and shoes, chemicals, and machinery are other important manufactures. St. Louis, with more than 700,000 people, is the state's busiest city.

Missouri's Latin motto, *Salus populi suprema lex esto*, means "Let the welfare

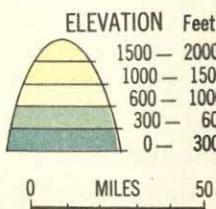
IOWA



State Bird: Bluebird

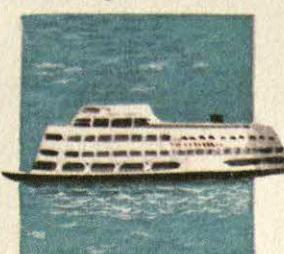
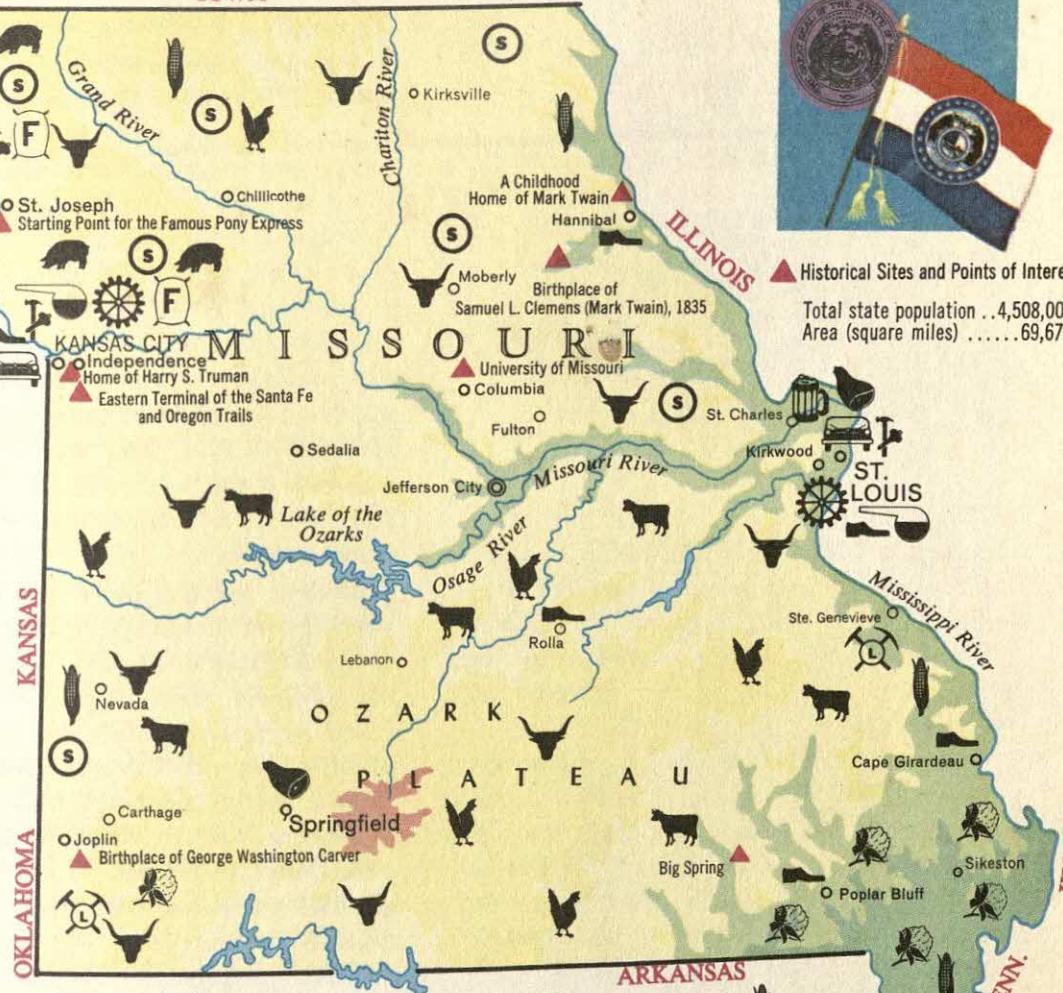


State Flower: Hawthorn

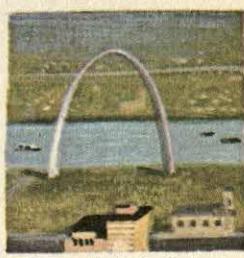


of the people be the supreme law." The state song is "Missouri Waltz." The flowering dogwood is the state tree.

Often Missouri is called the "Show Me State." No one is sure how this nickname came about. One story is that a Missouri congressman in 1899 made a speech in Philadelphia in which he said, "I'm from Missouri, and you've got to show me." Another story is that the nickname came about because the Missouri pioneers were independent and wanted to make up their own minds.



Modern Riverboat



Gateway Arch, St. Louis





MISTLETOE Some plants can be called thieves. Mistletoe is one of them. It grows on trees and steals water and minerals from them. It uses the water and minerals to make food. Mistletoe cannot grow on the ground and take in water and minerals from the soil as most green plants do.

The white berries of mistletoe plants are the favorite food of some kinds of birds. Seeds of the berries a bird eats may go through its body unharmed and be left on another tree. As a seed starts to grow, the baby plant sends rootlets into the tree trunk. They begin to soak up the water and minerals which the tree has taken from the soil for its own use. Soon the little mistletoe plant has green leaves. In time it has yellow flowers and, not long afterward, white berries.

Mistletoe grows on many kinds of trees. A single plant may grow to be as big as a barrel. In southern United States there may be so much mistletoe on a tree that it is hard to see the tree. Some trees die because they have too much mistletoe stealing water and minerals from them.

Mistletoe is gathered and sold at Christmastime. With its white, waxy berries and green, leather-like leaves it makes pretty Christmas decorations. Hanging up mistletoe at Christmastime is an old custom. Anyone standing under it may be kissed. Long ago in Europe mistletoe was supposed to have magic powers. (See PARASITES.)

MODERN ART A man looks down from an airplane thousands of feet above the ground. He sees a pattern of dark fields dotted with tiny spots of color which he knows are houses and barns. He sees straight white ribbons of roads and sometimes a curving blue line which he can tell is a river. What he sees is more like a map than a picture. At least it is not like the real-looking pictures of farms and roads and rivers many people have in their homes. Instead, it is an abstract pattern. Many artists of today like to paint abstract patterns—spaces of green, blue, red, and other colors. They like such abstract pictures better than realistic ones.

Modern painters make abstract pictures not only of landscapes but also of such things as people, flowers, and trees. Even the simplest abstract painting has often taken very thoughtful, careful planning. Many artists who have become famous for their abstract paintings first spent years practicing how to draw realistic people, plants, and landscapes. Working on lifelike pictures seemed to help them make better abstract patterns later.

Color photography helped bring about abstract painting. Artists said to themselves, "We need not paint realistic pictures. The camera can make them. We will do something the camera cannot do."

Some modern artists have liked to paint pictures that are only partly abstract, or semiabstract. In a semiabstract picture of a person you may see half of his face and half of one hand along with circles, squares, triangles, and lines—all put together to form one design.

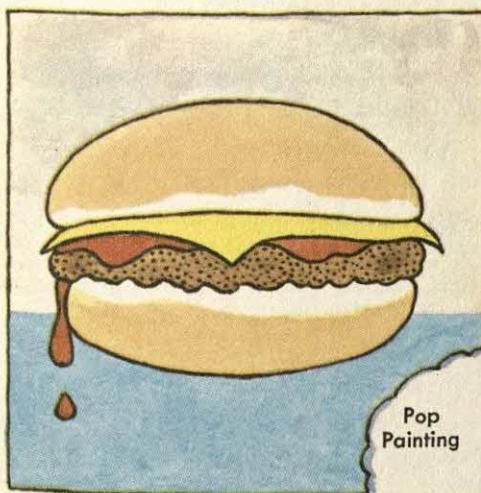
Abstract painting fits in well today with modern inventions. While scientists are inventing rockets, atomic reactors, and pocket-sized radios and television sets, artists are inventing ways of putting shapes together. A painter who makes an abstract painting of a person has to be creative in a different way than if he posed the person and painted him just as he saw him.

Much modern sculpture, like much modern painting, is abstract. It fits in, just as abstract painting does, with the thinking and feeling of the times.

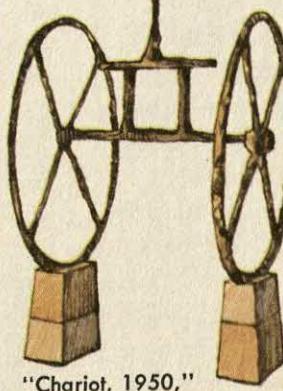
Some modern artists like to make patterns that will move. Many have made sculptures of the kind called mobiles. Some artists have experimented with painting designs and patterns on motion-picture film. When the film is run through a projector, the painted patterns move as they are projected onto a screen.

Of course, modern art is not just a matter of pictures and sculptures. Modern artists are designing wrapping paper, wallpaper, and fabrics. They are making beautiful glassware and pottery. They are designing buildings and automobiles and furniture. They are even designing vacuum cleaners and kitchen cabinets. Art has come very much into our everyday lives.

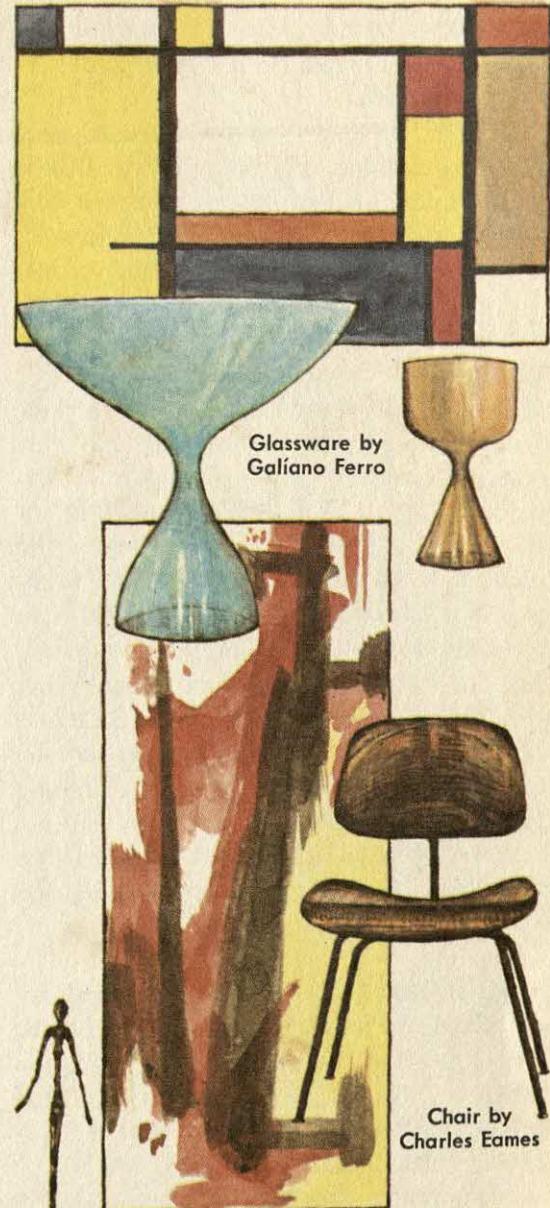
Some of the art of today is hard for people to understand. They can understand modern art better when it is applied to furniture and buildings than they can understand modern painting and sculpture. Modern houses and chairs and tables usually look like houses and chairs and tables. On the other hand, modern painting and sculpture do not always look as people expect them to. When they see no nose on a head done by a modern sculptor, or perhaps only one eye in a modern painting, they



Pop Painting



"Chariot, 1950,"
Giacometti



Chair by
Charles Eames



"Nuclear Energy," Henry Moore

say, "I hate modern art." The artist is not there to explain that he has tried to create a beautiful form.

Modern designers think a great deal about usefulness and simplicity. Heavy carved furniture that was suitable for castles is not suitable for small modern homes. Houses that are easy to take care of are better liked than more elaborate ones.

New inventions bring about changes in art, too. The invention of big passenger planes brought about new ideas of interior decoration. Scientists found out that certain colors made passengers high in the air feel gloomy. The brilliant sunlight up above the clouds, the dimness when the plane flew through a cloud, and the darkness of a storm all had to be thought of in planning colors for the inside of a plane. The invention of television meant that rooms had to be designed so that more people could sit where they could see the television set. Modern art keeps changing to meet new needs.

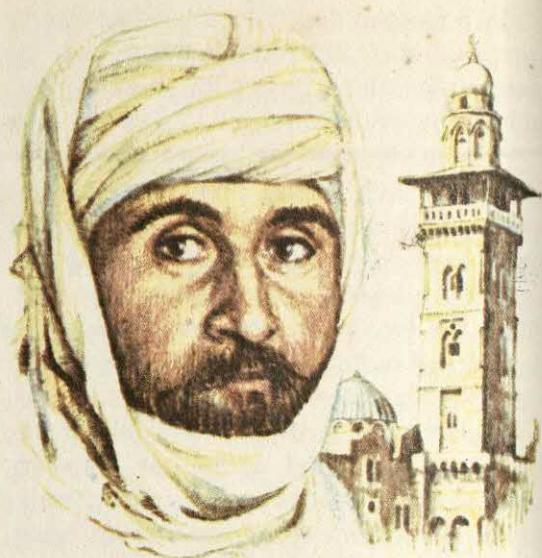
A new kind of modern art is called pop art. The artist as a rule pictures something familiar to everyone. (See SCULPTURE.)

MOHAMMED (570-632) In the world today there are almost 500,000,000 Moslems. They are the followers of the religion taught by Mohammed. The name of the religion is Islam. In Arabic it means "surrender to the will of God."

Mohammed was born in the year 570 in the city of Mecca in Arabia. Mecca was on the spice route from the Far East.

When Mohammed was very young he was left an orphan. A kind uncle took care of him and soon began taking him on camel caravan trips. At 25 Mohammed married a rich widow. He became a merchant.

Most Arabs in those days worshiped idols. In Mecca there was a shrine called the Kaaba. "Kaaba" means "cube." The shrine was a cube-shaped building in which there were many idols. In one corner of it was the Black Stone. This stone had



fallen from the sky long before. We would call it a meteorite. The Arabs made special journeys to Mecca to come to the Kaaba and worship idols there.

But Mohammed believed in one God just as the Jews and Christians did. He was familiar with the Bible, and he thought very highly of the teachings of Jesus. At last he had some revelations that he believed came from God, and he began to preach a new religion to the Arabs.

But many of the people of Mecca did not want to give up their idols. They became so angry with Mohammed that he had to flee from Mecca. He went to the city of Medina. The year was 622. Moslems call his flight the Hejira. They count their years from the Hejira. Our year 622 is their year 1.

In Medina Mohammed won many followers. Soon he was leading them in battles to make others accept his religion. In 630 he returned to Mecca and destroyed all the idols, but not the Kaaba or Black Stone.

From then on Islam spread fast. Mohammed died in 632, but it kept on spreading. In less than 100 years the Moslems had conquered northern Africa and much of western Asia and Spain. Today, most of the people of North Africa, the Near East, Pakistan, and Indonesia are Moslems. There are others in India and the Soviet Union.

Moslem churches are called mosques. Every mosque has at least one tall tower, or minaret. The picture of Mohammed shows a minaret in the background. From minarets criers call the people to prayer.

The Moslem name for God is Allah. The sacred book is the Koran. It is the Moslem word of God as given to Mohammed.

Every Moslem has five "pillars," or duties he must perform:

He must declare that there is no God but Allah and Mohammed is his messenger.

He must pray five times a day publicly. In prayer he must kneel and face Mecca.

He must fast for the month of Ramadan. During the whole month he must not eat between dawn and sunset.

He must give alms to the poor.

Once during his lifetime, if he can do so without hardship, he must make a pilgrimage to Mecca.

Moslems are not allowed to drink any alcoholic drink. They are not allowed to eat pork. They may not charge high interest on money they lend. A man may not have more than four wives.

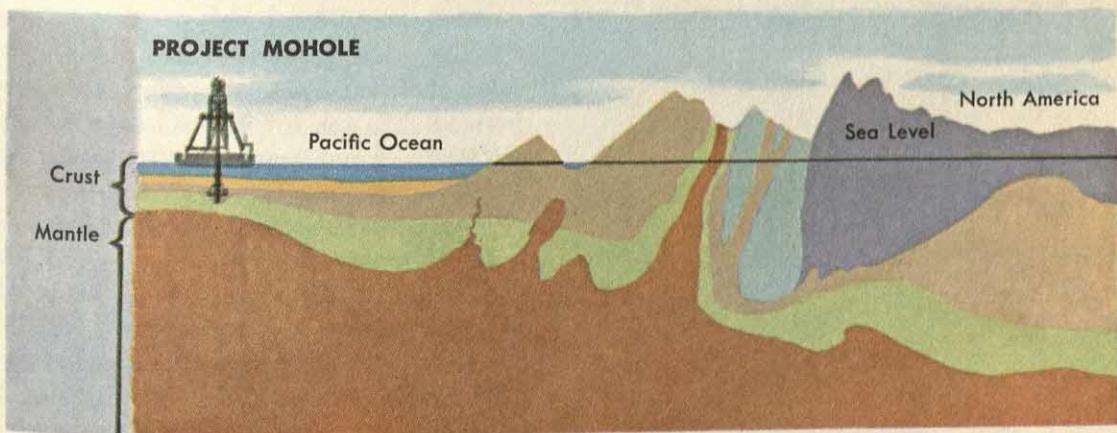
The Kaaba, which is within the walls of the Great Mosque of Mecca, is the holiest shrine of the Moslems. It is covered with a black "robe" embroidered with gold. The Black Stone has cracked and is now bound in silver. Other shrines are in the cities of Medina and Jerusalem. (See ARABIA; MOORS; RELIGIONS OF THE WORLD.)

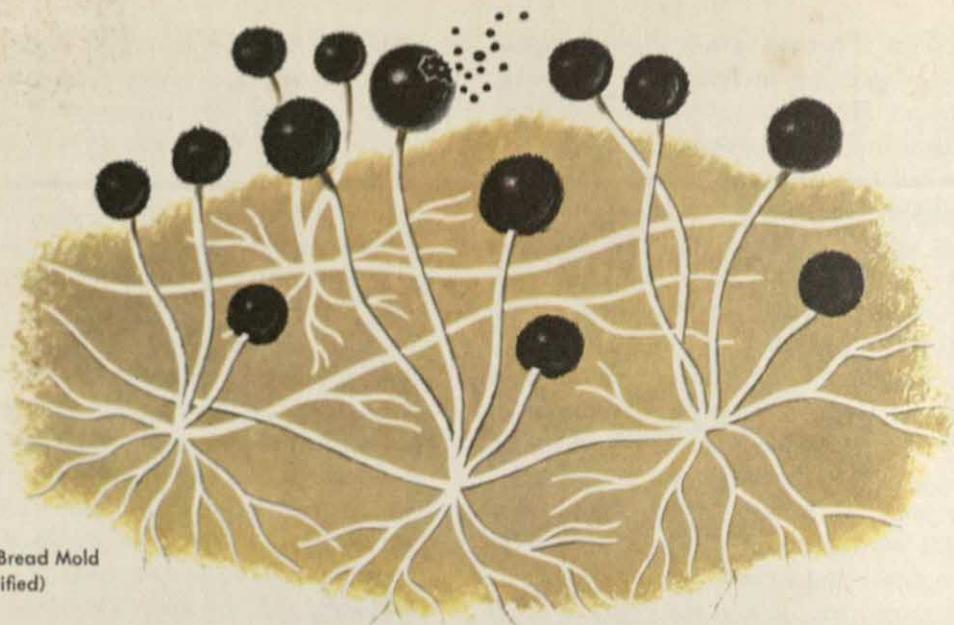
MOHO The innermost part of the earth, scientists believe, is a core of metals, mostly nickel and iron. The core extends out from the center of the earth for nearly 2,200 miles. It is surrounded by a layer of very hot rock some 1,800 miles thick. This layer is called the mantle. Surrounding the mantle is the earth's crust. It is very thin—only from 3 to 35 miles deep.

The borderline between the crust and the mantle is called the Moho. It is named for the geologist Andrija Mohorovičić. In studying earthquake waves in 1909, he discovered that, not far below the earth's surface, the rocks suddenly change. This sharp break was accepted as the dividing line between the crust and the rocks below.

Finding out how the rocks of the mantle differ from those of the crust would help scientists solve many puzzles, some of those about mountain building, for instance. American scientists made a plan—Project Mohole—for drilling down to the Moho.

Project Mohole called for drilling down from the floor of the deep sea, where the Moho is much nearer the surface than it is under the continents. But even there it would take some three miles of pipe to reach sea bottom, and then at least three miles of drilling through solid rock to reach the mantle. The great heat the drill would meet would be a problem. Project Mohole was started but was costing so much that it was given up. (See GEOLOGY.)





Black Bread Mold
(Magnified)

MOLDS Patches of white on the top of a glass of jelly, black fuzz on bread, blue-green spots on a rotting orange—these are all mold plants growing. Molds belong to the group of plants called fungi. They cannot make their own food as green plants do. Instead, they must get it ready-made. Molds can use many different kinds of things as food. They can live on bread or meat or fruit or almost any other of the foods we eat. They can live, too, on cloth, paper, wood, and leather. In fact, they can use as food almost anything that comes from a plant or an animal. Some even grow on living plants or animals.

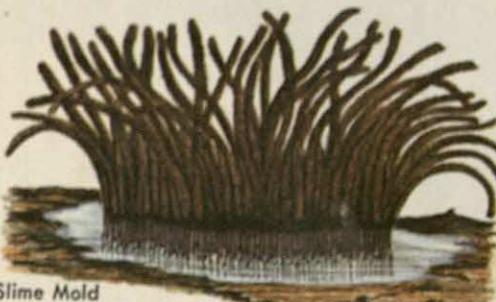
Mold plants are made up of almost colorless threads. But most mold spores are colored. Spores serve mold plants as seeds. A patch of blue-green on an orange means that the mold growing there is ready to

send millions of blue-green spores on their way to find new places to grow. There are so many mold plants and each plant sends forth so many spores that there are mold spores in dust everywhere.

Molds grow best where it is dark, warm, and damp, and where the air is still. Dampness is very important. A few molds even live in water. Sunshine, cold, dryness, and moving air are all good helps in keeping molds from growing where we do not want them. They help us keep molds from ruining food and books and clothing.

But we do not always want to keep molds from growing, for they help us in some ways. Roquefort cheese is blue because of mold growing in it. The mold gives the cheese a flavor many people like. Molds help make dead plants and animals decay. More important still, we now get some wonderful medicines from molds. Penicillin is one. This drug has saved many lives.

Slime molds have spores, but they are not true molds. They puzzle scientists because they are like plants in some ways and like animals in others. Some scientists call them neither plants nor animals but protists. (See ANTIBIOTICS; DUST; FUNGI; PLANT KINGDOM; PROTISTS.)



Slime Mold



MOLECULES A cup of water is made up of billions of tiny particles of water with spaces between them. These particles are called molecules.

The molecules in a cup of water are always moving. If the water is cooled, the molecules slow down and move less freely. If it is cooled enough, it changes to solid ice. But still the molecules are moving. If the water is heated, the molecules move faster and farther apart. The water takes up more room. If it is heated enough, the molecules move so far apart that the water becomes an invisible gas. When a little sugar is put in a cup of water, the sugar goes between the molecules of the water. It disappears. We say that it dissolves.

No one has ever seen a molecule of water. A water molecule is far, far too tiny to be seen with our eyes alone. It is far too tiny to be seen with even our best microscopes. But scientists decided years ago from the way it acts that water is made up of molecules. They saw no better way of explaining how water can be either a solid, a liquid, or a gas; no better way of explaining how such things as sugar can dissolve in it; and no better way of explaining how a cupful of it can get bigger or smaller.

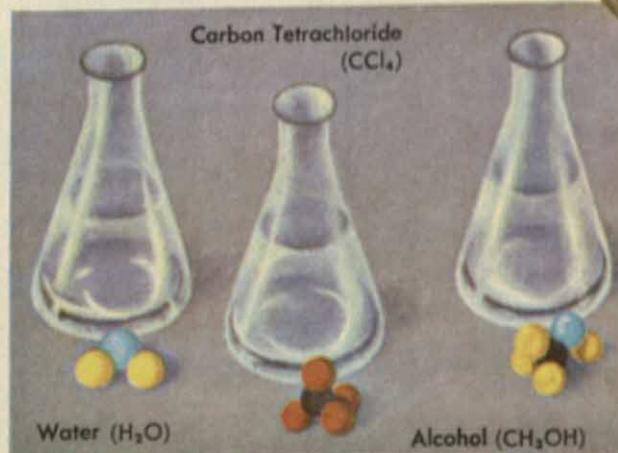
Thousands and thousands of other substances are made up of molecules, too. But, of course, not all molecules are alike. Sugar is made up of sugar molecules. Oxygen is made up of oxygen molecules. Air is made up of oxygen molecules and of other kinds, too. And so it goes. Always the molecules are moving, and always there are spaces

between them. Even in the solid wood of a table and the plaster on a wall the molecules are moving.

Most molecules are far too small to be seen. But a few kinds have been seen with powerful electron microscopes.

Molecules are made of even smaller particles called atoms. The atoms in a molecule may be all alike or they may not be. A molecule of water is made of two atoms of hydrogen and one of oxygen. A molecule of oxygen is made of two atoms of oxygen. The picture shows models of three kinds of molecules. The models are not supposed to show how the molecules really look. They are supposed only to show how many and how many different kinds of atoms make up each molecule.

Today scientists are inventing many new materials. They are making some of them by making different kinds of atoms join in new ways to form new kinds of molecules. (See ATOMS; CHEMISTRY.)



MOLES AND SHREWS Their fur shows that moles and shrews are mammals. They belong to the group of insectivores, or insect eaters. Their sharp teeth can easily cut through the hard coverings of insects.

Moles catch insects and worms underground. They dig tunnels to find them. Shrews catch most of the insects and other small animals they eat aboveground. Moles are not often seen, because they stay underground all the time. Shrews are not often

seen, either. They dash about night and day in runways burrowed in rotting leaves and other plant debris on the ground. People who do catch glimpses of them often mistake them for field mice.

Both moles and shrews are very energetic. Both, therefore, need a great deal of food. A mole will eat its own weight every day. A shrew eats two or three times its weight in a day. Even so, moles and shrews do not eat great piles of food, for they are small animals. A mole is about six inches long. Most shrews are four inches or so long—smaller than mice. The pygmy shrews are the smallest of all mammals. The smallest of the pygmy shrews is only two inches long and weighs only about as much as a dime. This tiny bundle of energy breathes more than 800 times a minute.

A mole is very well fitted for living underground. Its big front feet are excellent shovels. Its long, sharp claws are also a help in digging. Its thick fur keeps out water well. Its nose is very sensitive. The star-nosed mole, as the picture shows, has a circle of feelers at the tip of its nose.

An animal does not have to be big to be fierce. Shrews are bloodthirsty little animals. They may kill and eat one another.

Moles ruin lawns by digging their tunnels. In a single night a mole may dig a tunnel 100 yards long. But moles and shrews help us by eating harmful insects.

MOLLUSKS Snails, clams, and squids belong to the big group of invertebrates called mollusks. Most of them live in the water, some in fresh water, some in salt water. A few kinds live on land. Some are no bigger than grains of sand. But a giant squid may be 60 feet long.

The word "mollusk" comes from a Latin word meaning "soft." All mollusks have soft bodies. But most of them have hard shells. Many mollusk shells are beautiful.

Snails and clams and squids do not look much alike. But they are built on very much the same plan. Each has a muscular foot.



Each has a wall called a mantle that surrounds its heart, stomach, and other organs. If a mollusk has a shell, this shell is made of material secreted by the mantle. All mollusks except the clams and their close relatives have peculiar tongues with many rows of tiny teeth on them.

There are about 100,000 kinds of mollusks. Most of them are in three big groups. Each of these groups has a name that tells what kind of foot the animals in that particular group have.

Snails are gastropods. "Gastropod" means "stomach-foot." A snail crawls along on a broad foot and carries its shell on its back. The shell is all in one piece. As a rule it is coiled. The slugs are gastropods, too, but they have no shells.

Clams are pelecypods (pe LES i pods). "Pelecypod" means "hatchet-foot." The mollusks in this group do not crawl about on their foot. Instead, they use it for burrowing and, at times, for pulling themselves along. All the mollusks in this group have shells, and all the shells are made in two parts, or valves. Because of their shells, pelecypods are often called bivalves. "Bivalve" means "two-valve." As you see from the diagram, the bivalves include the oysters, mussels, and scallops.

Squids are cephalopods (SEF a lo pods). "Cephalopod" means "head-foot." The foot of a cephalopod is divided up into arms that surround its head. Squids have no shells that show. They have a small plate buried in the mantle. The octopus, another mollusk in this group, has no shell at all. On the other hand, the nautilus, another head-footed mollusk, has one of the most beautiful of all shells.

As the diagram shows, tusk shells and chitons are mollusks, too. These groups are both rather small.

Mollusks furnish us with enormous amounts of food. Their shells supply us with material for buttons. And all real pearls are found inside mollusk shells. (See PEARLS; SHELLFISH; SHELLS.)



fossil ancestors of mollusks



MONACO Most countries are measured in square miles. The tiny European country of Monaco is too small to be measured in miles. In it there are only 370 acres. About 25,000 people live there.

Monaco is a famous playground. It is on the shore of the Mediterranean Sea only a few miles from the French city of Nice. The towns of Monaco are on high bluffs. No towns in the world are in a prettier setting. Most of the people of Monaco make their living in the many hotels for tourists there. The most famous town in this small country is Monte Carlo. It is famous partly for its great gambling casino.

Monaco's ruler is a prince. One of Monaco's princes started a marine museum that is now one of the world's finest. The present prince is Rainier III. His consort is the former Grace Kelly of the United States.

MONARCHY Some countries are ruled by a person called a monarch. The monarch may be a king or queen, an emperor or empress, a prince, a shah, a grand duke. Monarchs have been known by many titles—those of ancient China were khans, and those of ancient Egypt pharaohs. Germany had its kaisers and Russia its czars. A country with a monarch is called a monarchy.

The monarchs of ancient times could do as they pleased with the people they ruled. "Off with his head" was far too common an order when a monarch was displeased. Today most countries ruled by monarchs have laws telling what the ruler can and cannot do to his people. In some cases the ruler has very little power. He is a figure-head. In the minds of his people the ruler stands for the country.

A monarch usually has a crown and a scepter to show that he is the ruler. In most cases the crown and scepter are made of gold. They may have beautiful jewels set in them. The chair on which the ruler sits on state occasions is called a throne.

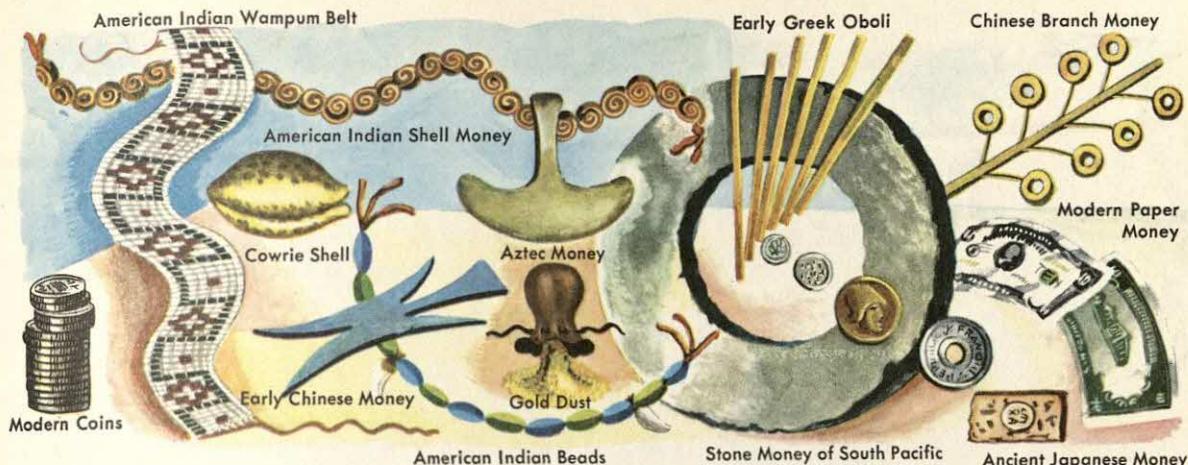
The great days of monarchs are over. Not many monarchies are left. Britain, Norway, the Netherlands, Sweden, Belgium, Japan, Ethiopia, Saudi Arabia, Iran, and Thailand are among those of today. A meeting of all the world's crowned heads would not need a very big room.

In monarchies the rulers inherit their titles. Every monarchy has its rules as to how the crown is handed down. Queen Elizabeth II of England became queen when her father, George VI, died. George VI became king when his brother, Edward VIII, gave up the throne. Edward VIII inherited the crown from his father, George V; George V inherited it from his father, Edward VII; and Edward VII became king when his mother, Queen Victoria, died.

The family from which the rulers of a monarchy come is called the royal family. In addition to the royal family there are usually other nobles in a monarchy. In England there are, for instance, dukes and earls. The people of a monarchy have a chance to see their ruler and all their nobles at certain great occasions. One of them is the crowning of a new ruler. (See COMMUNISM; DEMOCRACY; MAGNA CARTA; SOCIALISM.)



King Knighting Subject



MONEY How surprised a workman in a modern factory would be if at the end of a week he were paid his wages in dried fish, little copper hatchets, lumps of rock salt, or shark's teeth! But all these things have been used as money in some place at some time. Among the other strange kinds of money are carved pebbles, tobacco, bricks of tea, porcupine quills, jawbones of pigs, furs, coconuts, cattle, camels, ivory, elephants, and arrowheads.

One of the first kinds of money—perhaps even the very first—was the ox. Our word *pecuniary* (having to do with money) comes from *pecus*, a Latin word for cattle.

Shells were another very early kind of money. Of all the many kinds of shells those of the cowrie, a sea snail, have been most used as money. Some primitive peoples use shell money today.

Metals, too, have been used as money for thousands of years. Gold, silver, copper, and bronze (a mixture of copper and tin) were the first metals used. Later iron, lead, and nickel came into use.

All the early kinds of money were alike in certain ways. They were all things which, for some reason or other, people wanted. They were all fairly lasting. And they were easy to identify. Bananas would not make good money; they spoil too easily. Neither would diamonds or sand. It is too hard to tell real diamonds from imitation ones. Sand is too common.

Little by little in civilized countries the metals crowded out other kinds of money. At first the metal was not made into coins. Instead it was in little bars or ingots, which had to be weighed at each transaction. In the story of Babylonian money we read of the shekel, the mina, and the talent. These were really weights. A shekel was the weight of 180 grains of wheat. Sixty shekels equaled one mina, a little more than our pound. A talent was 60 times as much as a mina—about 66 pounds.

As far as anyone knows, the first coins were made in Lydia, a little country in Asia Minor. These coins were made of electrum, a mixture of gold and silver. They had a design stamped on them.

Coins were a big advantage. They could be counted instead of weighed. By the design he stamped on a coin, the coinmaker gave his word that there was a certain amount of metal in the coin.

Governments soon decided that they should make the coins. Croesus of Lydia, famous for his riches, was probably the first king to take over the making of coins.

Many coins now have pictures of rulers and patriots on them. The first great man ever to have his picture put on a coin was Alexander the Great.

In the early days of coins people sometimes cheated by trimming a little metal off the edges of the coins. Now coins are made with milled edges—edges that are

raised or grooved so that it is easy to see whether the coins have been trimmed.

Much of the money used throughout the world today is paper money. It is very convenient. A thousand dollars in gold is easier to carry about than \$1,000 in cattle or shells or arrowheads, but a thousand-dollar bill weighs only a tiny part of what \$1,000 in gold weighs.

Is paper so valuable that a piece of it is worth many times its weight in gold? Not at all. A plain piece of paper the size of one of today's bills would buy almost nothing. A bill is worth the amount printed on it simply because the government that prints it says it is. A workman takes a ten-dollar bill in payment for some work he has done because he knows that with it he can buy ten dollars' worth of such things as milk and meat and shoes.

In the early days of the American colonies wampum, musket balls, and tobacco were used as money. Wampum was made of clamshells. Much of the trading with the Indians was done with it. Tomahawks, too, were used in trading with the Indians.

One of the early coins made by the colonists was the pine-tree shilling. Much of the silver for this and other coins the colonists made was brought in by pirates. Strange as it seems, the most used coins in the colonies came to be "pieces of eight," famous in stories of pirates, instead of coins made in the colonies.

In regions where tea grows, bricks of tea have been used as money.

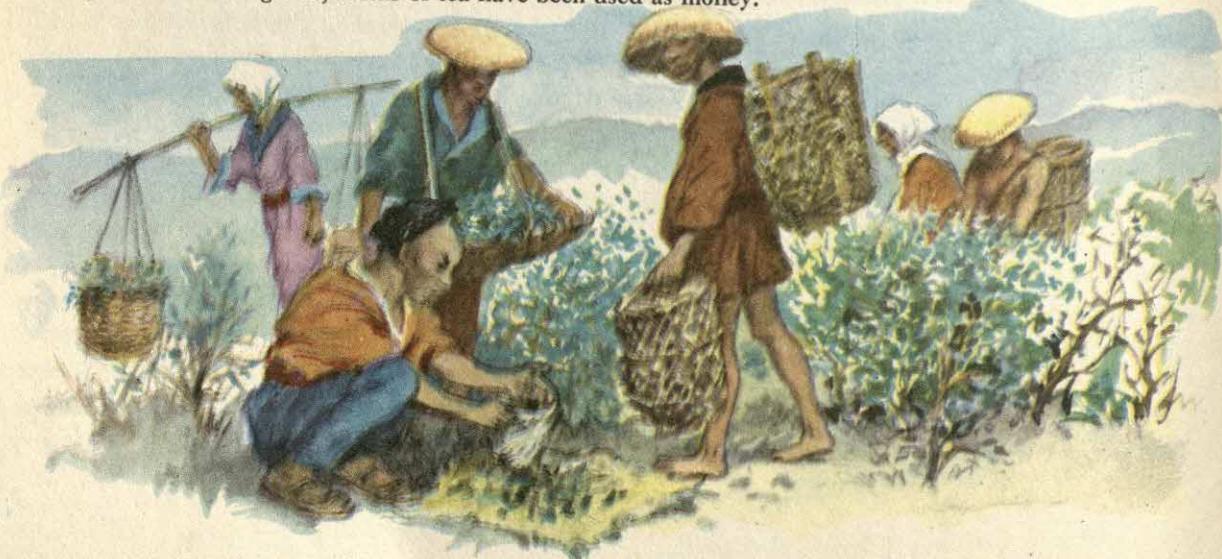
Pieces of eight were Spanish dollars. Their name came from the fact that each one was worth eight of the small coins called reals. Another name for a real was a bit. Once in a while people still say "two bits" when they mean a quarter.

During the Revolution the Continental Congress issued paper money. The money failed because people did not have enough faith in the government. "Not worth a continental" means worth nothing.

Shortly after the end of the Revolutionary War the new government of the United States set up a mint in Philadelphia. Soon dollars, half-dollars, dimes, half dimes, quarters, eagles (ten-dollar gold pieces), and half eagles were being coined. Later the nickel was made instead of the half dime, and pennies and twenty-dollar gold pieces were added.

In time the government issued paper money. It was easier to handle in large amounts than coins.

In 1933 the government called in all gold coins. Today's coins, like paper money, are worth what they are marked, not because of the value of the metal in them, but because the government stands back of them. In the late 1960's the government, to save silver, decided to change from silver quarters and dimes to sandwiches of nickel and copper marked the same way. The new coins were used along with the older ones and bought just as much.





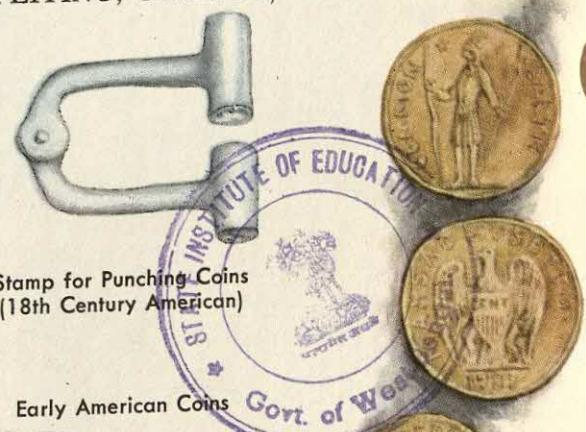
Workers Pouring Silver into Molds in an 18th Century American Mint

Getting along without money is hard to imagine. Money is a help in a number of ways. It is a yardstick which measures how much anything is worth. A farmer, let us say, wants a television set. He finds that the price of the set is \$200. He has eggs to sell. The price of eggs is 50¢ a dozen. He sees that it will take 400 dozen eggs to get the television set he wants.

Money is also a kind of bridge between the buyer and the seller. The owner of the television shop certainly would not want 400 dozen eggs. But the farmer can take his eggs to a dealer, get money for them, and pay it to the television seller.

Money, moreover, gives us a way of saving. If the farmer saved eggs until he had 400 dozen, the oldest ones would not be fresh. But he can sell his eggs every day and save the money until he has enough.

Money has helped build strong governments because it has made the payment of taxes simple. It has helped people and nations trade with one another. Money has made it possible for some people to save enough to found great museums and colleges and libraries. Certainly money is one of man's great inventions. (See BANKS AND BANKING; BARTER; COUNTERFEITING; CROESUS.)



Early American Coins





MONGOLIA A great region in the heart of Asia between the U.S.S.R. and China is called Mongolia. It gets its name from the Mongols, the natives of the region.

The Mongols were once very powerful. Genghis Khan, the conqueror who pushed his way into Europe nearly eight centuries ago, was a Mongol. So was Kublai Khan, the ruler of China when Marco Polo made his famous trip to the Far East.

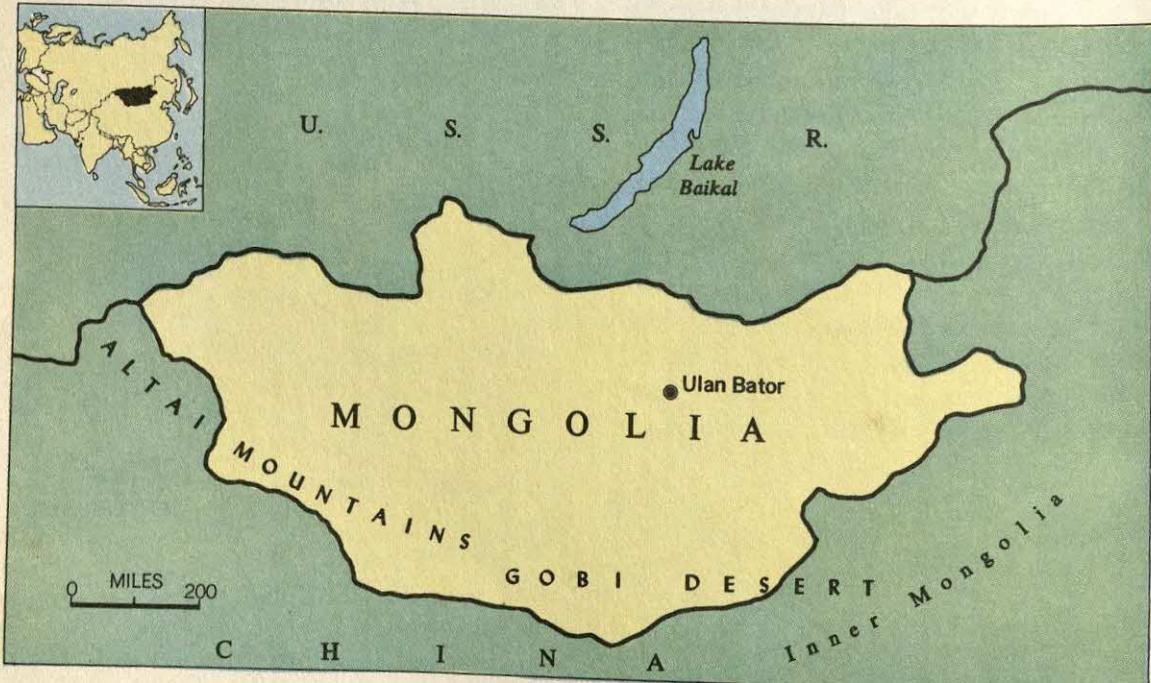
The Great Wall of China stretches for about 1,500 miles along the border between Mongolia and China. It was built before the time of Christ to protect China from the tribes of Mongolia. Later, in the days of Genghis Khan, no mere wall could shut the Mongols out.

The Gobi Desert takes up a big part of Mongolia. Very little of this vast region is suited for farming. Many of the people are nomads. They have big herds of sheep. They own horses, cattle, and camels, too. Their houses are tents made of felt.

Many people think of a desert as being lowland. But the Gobi Desert is high. In places it is a mile above sea level. The winters are cold. Even in summer the nights are very cool.

Most of the travel in Mongolia is by pony or by camel caravan. But there are now roads that automobiles can travel. Airlines and railways link Mongolia with China and the Soviet Union.

Part of Mongolia is controlled by China. It is called Inner Mongolia. In it, under Chinese guidance, the nomadic way of life has given way to settled agriculture. Another large part, Outer Mongolia, is a separate country, the Mongolian People's Republic. There are signs of changes in living here, too. On the railroad between the capital, Ulan Bator, and Ulan Ude in Siberia, freight trains now carry in one trip as much as 8,000 camels used to carry. Most of the trade is with the Soviet Union. (See ASIA; GENGHIS KHAN.)





MONGOOSE A mongoose looks a little like a weasel. Both these animals are carnivores. But mongooses are much closer relatives of some of the other carnivores—the cats and hyenas, for instance—than they are of weasels. Mongooses are found in Africa, southern Europe, and Asia.

The common mongoose of India is well thought of, for it kills snakes. It even kills the king cobra, one of the most poisonous of all snakes. A favorite story of Kipling's, "Rikki-tikki-tavi," is about a mongoose that kills a king cobra.

A mongoose is not immune to the poison of snakes. It simply takes care not to be bitten. It can move so fast that it is able to get out of the way as a snake strikes. Mongooses are among the world's most active animals. Snakes are not the only animals they kill. They also kill rats, mice, and many other kinds of small animals.

In 1872 some mongooses were brought from India to the island of Jamaica in the West Indies. They were brought to help get rid of the rats that were destroying the sugarcane there. Since there were plenty of rats for them to eat, the mongooses multiplied fast. Soon the rats became scarce. Then the mongooses did not find it easy to get food. They began eating chickens and wild birds. Before long they were a real pest. The story was much the same in Hawaii in 1883. Now no one is allowed to bring a mongoose into the states. (See BALANCE IN NATURE.)

"MONITOR" AND "MERRIMAC" The "Monitor" and the "Merrimac" were both warships. They were ironclads. They were, that is, built of wood, but they were covered with heavy iron plates. These two vessels fought a battle early in the Civil War.

The "Monitor" was built by a Swedish-American engineer for the North. It was called a "cheesebox on a raft." The vessel had a flat iron deck only slightly above water level. In the center was a revolving turret with two guns. The "Monitor" was much smaller than the "Merrimac."

The "Merrimac" belonged to the Confederate forces. Built in Massachusetts, it had been burned and abandoned by the Union forces when the war began. Southern engineers had covered the ship with iron, mounted ten guns on it, and given it a cast-iron ram at the bow. The ram could easily tear a hole in the side of a wooden ship.

The "Merrimac"—called by southerners the "Virginia"—had sunk two Union vessels the day before its battle with the "Monitor." But they were wooden vessels. It could not harm the "Monitor." After four hours of fighting neither vessel had won the battle. The "Merrimac" then steamed away, badly damaged.

The battle, though small, was one of the most important naval battles ever fought. It was the beginning of the change from wooden vessels to big steel warships.





MONKEYS Human beings belong to the group of mammals called primates. So do monkeys. Monkeys have hands just as we do. They have ten fingers and ten toes. They have brains much like ours.

There are two groups of monkeys—the Old World monkeys and the New World monkeys. Of the monkeys pictured, those on the tree are natives of the Americas. The others are from the Old World.

There are several kinds of marmoset monkeys in the forests of South America. Their fur is as soft as feathers, and their voices sound like the twittering of birds. The smallest of all monkeys is the pygmy marmoset of the Amazon region. It can curl up in the palm of a person's hand.

Howler monkeys get their name because they do a great deal of howling. Their howls are not pleasant.

Uakaris have old-man faces. They always look woebegone.

Once capuchins were often seen with organ grinders. They are common in zoos.

The spider monkey climbs as if it had five arms. Its tail is as useful as a fifth hand. With one hand this monkey can eat fruit, with another hand it can hold fruit ready to eat, with one foot it can gather more fruit, and with the other foot and tail it can swing from branch to branch.

Rhesus monkeys come from the jungles of India. There they live in big, noisy groups. These monkeys are used in many science experiments. Some have gone into space. The Barbary ape, a close relative, has no tail.

The proboscis monkey is large. From the tip of its nose to the end of its tail it is more than four feet long. This monkey gets its name from its big nose.

The dianas are handsome monkeys. In contrast, the mandrill is grotesque. But it has the distinction of having the brightest colors of any mammal.

Monkeys are probably the most popular of all zoo animals. They are fun to watch, but it is never safe to go too close to them. (See APES; MAMMALS; UAKARI.)

MONKS AND MONASTERIES No story of Europe could be told without telling about monks and monasteries. For all through the Middle Ages the monks did a great deal to keep learning alive.

Both "monk" and "monastery" come from a Greek word meaning "alone." The first monks were hermits. They were men seeking to get closer to God by giving up worldly things and living alone, away from other people.

The story of Christian monks and monasteries begins in the 200's in Egypt and the lands nearby. St. Anthony was not the first monk, but he is usually called the founder of the monastic way of living. He retired to a deserted fort on the east bank of the Nile and later to a mountain by the Red Sea. Although he chose to live mainly as a hermit, many Christians heard of his saintly life and became his followers. He and his followers did not live together, but they came together to worship. And they all followed certain rules.

At about the same time St. Pachomius brought together a group of followers. On an island in the Nile he and his followers built living quarters for themselves—a monastery. St. Pachomius also founded eight other monasteries and a nunnery.

In the 300's the monastery idea spread to Europe. Later the communities of monks were grouped into orders. And from time to time new orders were founded. St. Francis of Assisi, for instance, founded the order of Franciscans.

There are still many monks and monasteries. Most Christian orders are part of the Roman Catholic Church. The members of some are called canons rather than monks. Those of others are called friars. Some are called brothers. The members of women's orders are nuns or sisters.

LEADING CATHOLIC RELIGIOUS ORDERS

Augustinians	Jesuits
Benedictines	Little Sisters of the Poor (women)
Carmelites	Sisters of Mercy (women)
Dominicans	Society of the Sacred Heart (women)
Franciscans	Ursulines (women)

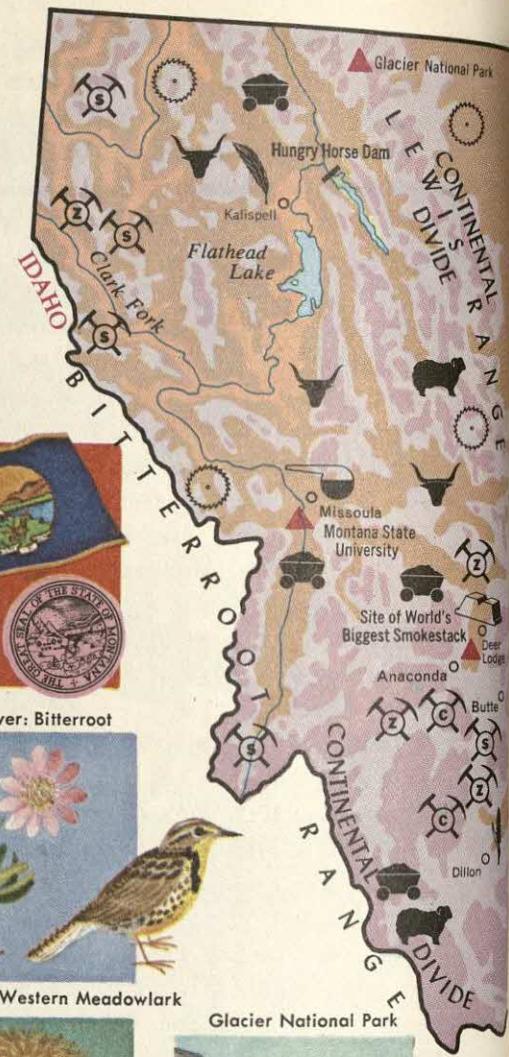
MONTANA This large northwestern state is true to its name, which means "mountainous region." Western Montana is crossed by Rocky Mountain ranges with high, snowy peaks. The eastern part of the state belongs to the Great Plains. Here are high, rolling lands broken by hills, mountains, and river valleys. Only Alaska, Texas, and California are larger than Montana. It is thinly settled, however, and ranks only 41st in population.

Its nickname, "Treasure State," is a good one for Montana. The state is rich in copper, gold, silver, zinc, petroleum, natural gas, coal, and precious stones. *Oro y plata*, the state motto, means "gold and silver." But Montana's greatest treasures are its farms and grazing lands.

In 1805, on their way to the Pacific coast, the Lewis and Clark expedition crossed the Montana country. The discovery of gold in the Rockies in the 1850's and 1860's brought eager groups of American settlers. Mining towns grew with the gold boom. About the same time, Texas cowboys began to drive their herds of cattle and horses northward to the Great Plains of Montana for summer pasture. Cattlemen laid out huge ranches on the plains. They shipped beef cattle to eastern markets on newly built railroads.

The early years were not peaceful. Bandits raided mining towns. The Sioux Indians under Sitting Bull wiped out General Custer's soldiers. After peace was made with the Indians in 1877, more settlers came to the Montana country. In 1889 Montana became the 41st state in the Union. The capital is Helena.

Today the farmers and ranchers of Montana bring wealth to the state despite big odds. On the Great Plains the summers are hot, with long dry spells and sudden cloudbursts. The winters are cold, with blinding snows. The fertile valleys in the Rockies lack rain. Irrigation systems help greatly. One of the largest earthen dams in the world is the Fort Peck Dam on the



State Flower: Bitterroot



State Bird: Western Meadowlark



Glacier National Park



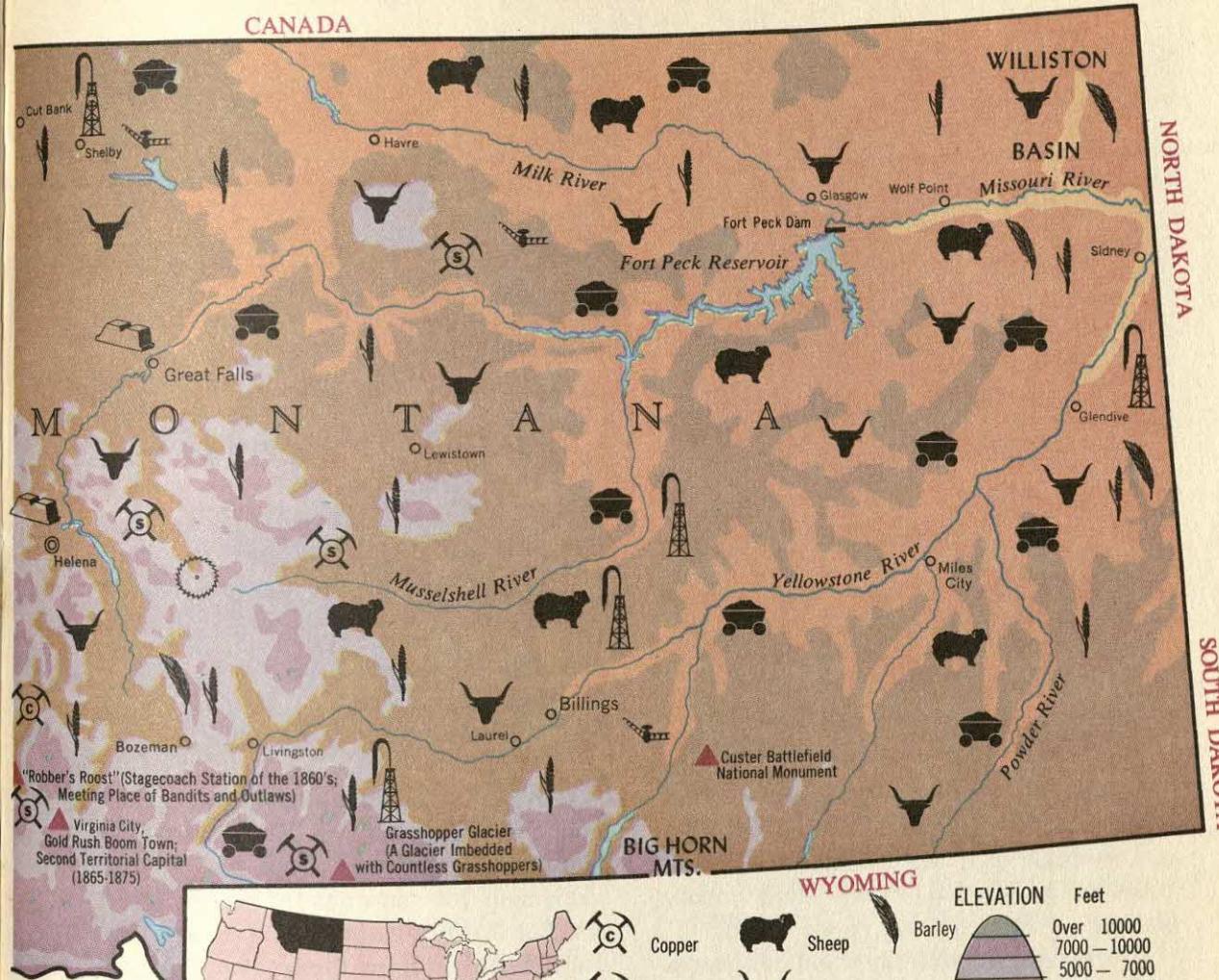
Missouri River. It not only stores water for irrigation but also produces electric power which is carried hundreds of miles to farms and cities. The Hungry Horse, among the ten highest in the country, is another of Montana's great dams.

Wheat is the most valuable of Montana crops. It is grown without irrigation on the plains. Fine beef cattle, sheep, and wool are products of the grazing lands. On irrigated lands dairy cows, sugar beets, vegetables, and fruits are raised.

CANADA

NORTH DAKOTA

SOUTH DAKOTA



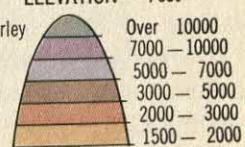
Historical Sites and Points of Interest.
 Total state population 702,000
 Area (square miles) 147,138

For many years copper was the most valuable mineral in Montana. Now it has lost its place to oil. Most of the mining of metal ores is in the western half of the state. The oil fields are in the eastern half. Montana's oil boom began with the finding of oil in the Williston Basin.

Butte is the great copper-mining city. Under its streets there are miles of mine tunnels that extend far into the mountains. The copper ore is taken to huge smelters at Anaconda, 26 miles away.

WYOMING

ELEVATION Feet

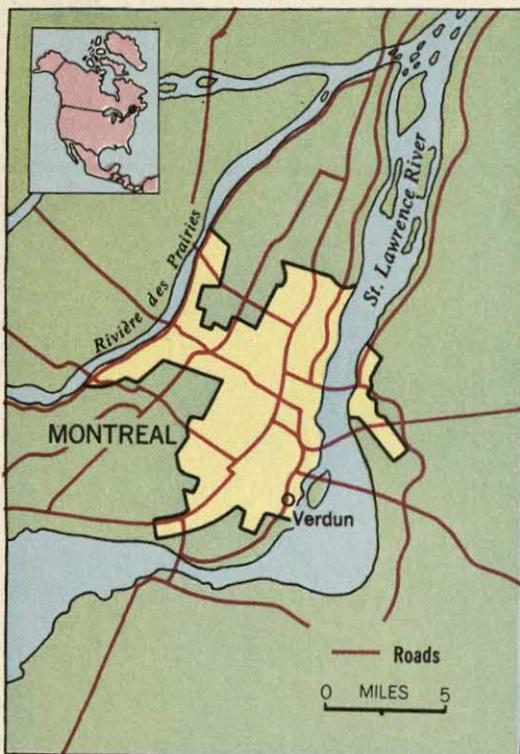


0 MILES 50

	Copper		Sheep		Barley
	Zinc		Beef Cattle		
	Silver		Lumbering		
	Coal		Chemicals		
	Wheat		Smelting and Refining		Oil
					Natural Gas

Montana has no very large cities. Great Falls, with a population of about 65,000, is the largest. Billings ranks second, and Butte third. All Montana's cities are trade, food-processing, or mining centers.

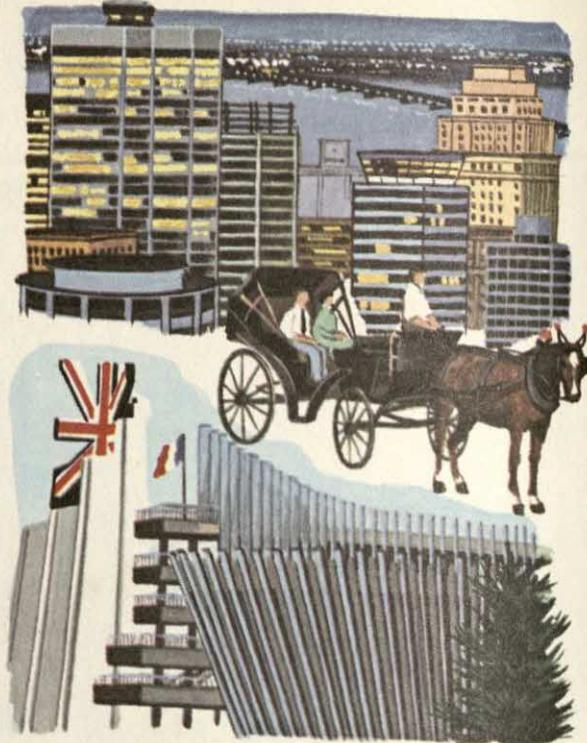
Glacier National Park along the Canadian border has many visitors each year. They like to follow the trails to the glaciers and lovely lakes high in the mountains. A bit of Yellowstone, too, is in Montana. Taking care of tourists is an important way people in Montana make a living.



MONTREAL One city of Canada is far bigger than all the others. This city is Montreal. Because of its size Montreal is sometimes called "Canada's New York." And, like New York, it is built on an island.

It is no wonder that Montreal has grown to be a city of over a million people. Its location is excellent. It is on the great St. Lawrence River at the farthest point inland that, until the opening of the St. Lawrence Seaway in 1959, large oceangoing vessels were able to reach. It has great docks for loading and unloading big steamships. Grain elevators, cold-storage plants, and warehouses line the docks in its harbor.

At the same time that Montreal is a good port, it is far enough from the sea—about 1,000 miles—to be deep in the heart of rich farmlands and forests. It is at the foot of a system of rivers, lakes, canals, roads, and railroads that bring to it grain, petroleum, lumber, meat, and dairy products for shipment overseas. Bridges over the St. Lawrence River and expressways leading to them make the city easy to reach from the United States.



Montreal is in the province of Quebec, a part of Canada that was first settled by the French. The city itself was founded more than 300 years ago by French explorers. The first French priest to say Mass there used the light from fireflies shut up in a bottle. Today the city is an interesting mixture of French and English. Many signs are in both languages. The city gets its name from a high hill that rises in its midst. "Montreal" in French (*Mont Royal*) means "Mount Royal."

Montreal has some narrow streets, many quaint old buildings, and an open market where vegetables and fruits from nearby truck farms are sold. It also has many wide avenues, beautiful homes and churches, and big hotels. In one of the towers of the Church of Notre Dame is a famous 12-ton bell. Montreal can boast of two fine universities. From the city's many factories come clothing, electrical goods, paper, meat, flour, tobacco, locomotives, and freight cars. Expo 67 helped make this great city of Canada known around the world. (See ST. LAWRENCE RIVER.)

MOON The moon is a satellite of the earth—it travels, that is, around and around the earth. Of all the heavenly bodies it is the earth's nearest neighbor; it is only about 240,000 miles away.

In the sky the moon looks as big as the sun. But it really is not. It looks as big as the sun because it is much closer to us. The moon is not even as big as the earth. If the earth were hollow, there would be room inside it for at least 50 moons. The sun would hold 50 million moons. The earth is not the only planet with a moon. Some planets have several. And some moons are larger than ours. But no other moon is as big as ours in comparison with the planet it travels around.

The moon does not give off light of its own as the sun does. It would not be bright if the sun did not shine on it.

It is not the same brightness all over. The lighter and darker spots make pictures. As they look at the full moon, some people see the face of a man. Some see a girl reading a book. Others see an old man with a bundle of sticks on his back. Still others see the figure of a jumping rabbit.

The people of long ago made up many stories to explain the pictures they saw in the moon. Now we know that the light and dark spots are made by mountains and plains. The mountains catch the sunlight better than the plains.

When people first looked at the moon through telescopes, they thought that the plains were seas. They gave the "seas" names, and these names have not been changed. So we find on a map of the moon such names as Sea of Showers (*Mare Imbrium*) and Lake of Dreams (*Lacus Somniorum*). Many mountains on the moon are named for mountains on the earth.

On the moon are also many great hollows called craters. Perhaps they are the craters of giant volcanoes. More probably they were made by meteors that hit the moon. The moon's surface is pockmarked with tiny craters, too.



Moon Craters

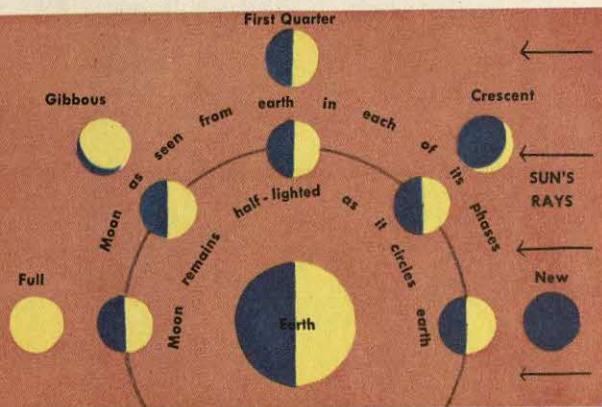
There is no air or water on the moon. There are no clouds. Shadows are very black with no air to scatter the sunlight. Viewed from the moon the sky is black, with stars shining all the time. Of course, without air and water there cannot be any living things of the kinds we know.

The moon has day and night just as the earth has, but each of its days and nights is about two of our weeks long. During the day the temperature goes above the boiling point. At night the temperature goes down to far, far below freezing.

Gravity on the moon is much less than gravity on the earth. A boy who weighs 90 pounds on earth would weigh only 15 pounds on the moon.

As we watch the moon in the sky night after night, it seems to change its shape.





One night it is a narrow crescent—often called the new moon. A few nights later it is a half-moon. In about a week it is big and round. We say that it is full. Then it seems to get smaller until it looks like a half-moon again. It goes on shrinking until for a night or two it cannot be seen at all. Scientists call this stage the new moon. Then once more the crescent moon appears.

Of course, the moon does not really change its shape. It seems to because it travels around the earth. The sun can light up only one half of the moon at a time. Once a month the sun, earth, and moon are in this position: ☽ ☽ ☽. Then the side toward the earth is not lighted up, and we cannot see it at all. But two weeks later the sun, earth, and moon are in this position: ☽ ☽ ☽. Then the sun can shine on all of the side toward us, and the moon is full. In between times some, but not all, of the side toward us is lighted up.

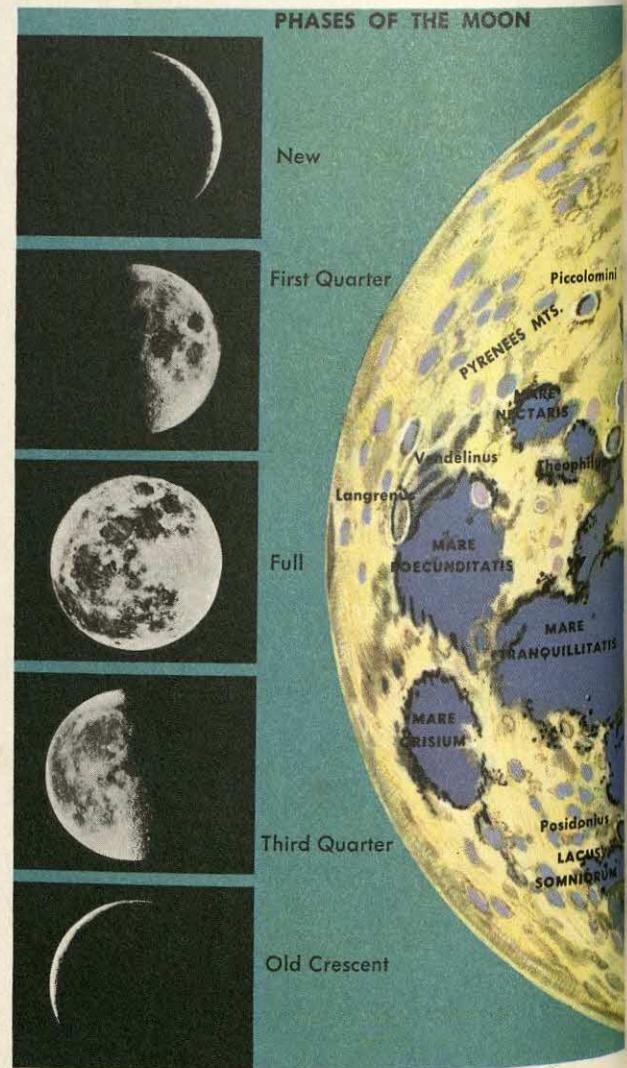
The journey of the moon around the earth also makes the time of moonrise change greatly from day to day. The moon may rise at any time of the night or day. In the daytime sky, however, the moon looks very pale.

Until the late 1950's all we knew about the moon had come from watching it from the earth. Scientists had used telescopes and other instruments to make their discoveries. But as soon as the Space Age began, with the orbiting of Sputnik in 1957, the story changed. Plans for moon shots, or probes, quickly got under way.

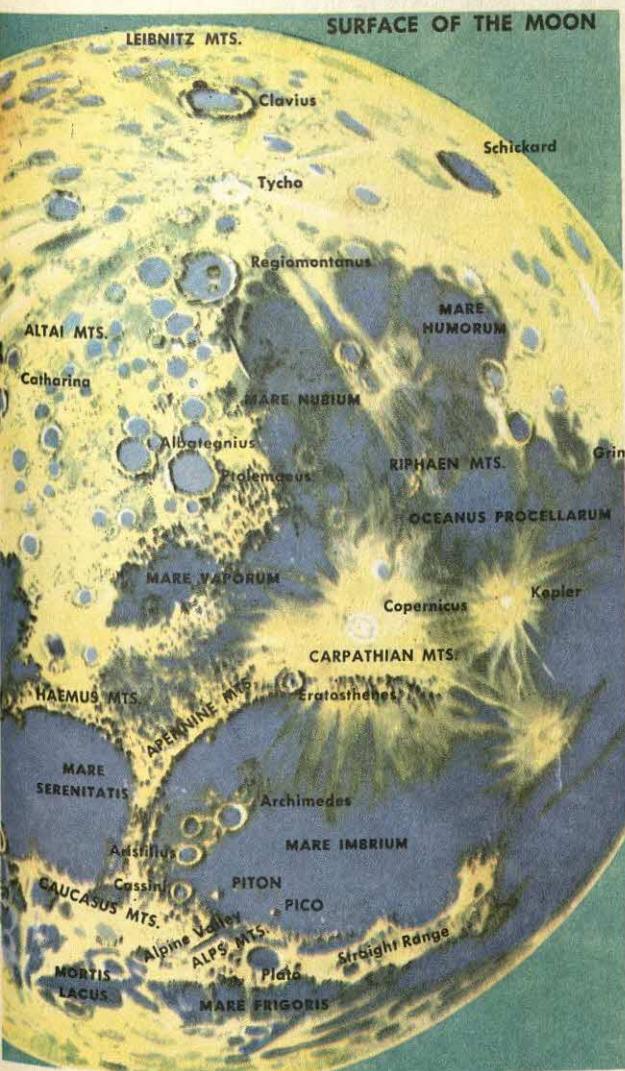
Both the United States and the Soviet Union have sent many unmanned spacecraft to study the moon. Some have passed close to the moon and gone on out into space. Some have circled the moon. Some have crash-landed on the moon, and others have made soft landings. The Russians have used Luna and Zond spacecraft. Among those sent up by the United States have been Rangers, Lunar Orbiters, and Surveyors.

From all these moon probes have come thousands and thousands of pictures. As the moon travels around the earth, it keeps the same side toward the earth. Not till spacecraft reached the other side of the moon could we be sure that it was much like the side we see. The spacecraft have sent back records of other kinds, too.

With the landing of space vehicles on the moon, man's age-old dream of going to the



moon became a possibility. The United States started its Apollo Project for landing men on the moon. The Soviet Union, too, made plans for a moon landing. Late in December of 1968 an enormous stride forward was taken. Apollo 8 carried three American astronauts across the 240,000 miles between the earth and the moon and went into orbit around the moon. It circled the moon ten times about 60 miles above its surface. The astronauts had an excellent chance to study the surface and form an opinion as to where the best regions for landing would be. They took many pictures. On their return trip they guided their spacecraft to a perfect splashdown. The question of a moon landing changed from "Can it be done?" to "How soon?" (See CALENDAR; ECLIPSES; PLANETS; ROCKETS; SATELLITES; SOLAR SYSTEM; SPACE TRAVEL; TIDES.)



MOORS Twelve centuries ago the Moslems were very powerful. They ruled over all the lands at the eastern end of the Mediterranean Sea and over the northern lands of Africa. They had even crossed the Strait of Gibraltar and conquered most of Spain. They might have spread over all Europe if Charles the Hammer, the ruler of the Franks, had not stopped them at the famous Battle of Tours in 732.

The Moslems of North Africa and Spain are often called Moors. They were a mixture of a people who had lived in North Africa earlier and Arabs who had conquered them. They spoke Arabic.

For several centuries the Moors ruled Spain. Their rule was by no means a dark age for Spain. Much of their governing was mild and just. And in those days the Arabs led the world in such subjects as mathematics, astronomy, and grammar. They had saved much of the learning of the Greeks by writing it in their own language. Our way of writing numbers came to us from the Arabs. So did many common words, among them algebra, alchemy, alcohol, cotton, coffee, and sherbet.

Many products of the East were brought into Europe by the Moors. Perhaps the most important was paper. Ships carried the products of Spain to Africa and Asia.

The Moors were great builders. One of their cities in Spain was Cordova. It was,

a thousand years ago, one of the world's great cities. Cordova had 3,000 Moslem churches, or mosques, 300 public baths, a great university, and many magnificent palaces. More than 10,000 weavers made beautiful Moorish carpets, curtains, and shawls. Granada was another famous Moorish city. In that city stands the Alhambra, the famous Moorish palace. The Moors were great storytellers. The American writer Washington Irving included some of their stories in a book called *Legends of the Alhambra*.

The Moors were finally driven out of Spain. They lost their last foothold, Granada, in 1492 just before Columbus set sail on his famous voyage. If Granada had not fallen, King Ferdinand and Queen Isabella might not have been willing to help Columbus. (See ALHAMBRA; HISTORY; IRVING, WASHINGTON; MOHAMMED.)

MORMONS The Mormons are the members of the Church of Jesus Christ of Latter-day Saints. This church is not an old one. It was founded in Fayette, N.Y., in 1830. The founder was Joseph Smith. When he was 14 Joseph Smith began having visions. They led him when he was still only 25 to found the new religion.

The name Mormon comes from the Book of Mormon, which is one of the sacred books of this church. Smith told of a vision that led him to a hill where he found tablets of gold on which the Book of Mormon was written in ancient Egyptian. Others wrote down what he translated from the tablets. The Bible, too, is sacred to Mormons.

At first Smith's church had few followers. But soon Mormon missionaries had made converts in a number of places. The Mormon headquarters moved westward to Ohio, to Missouri, and then up to Illinois.

Through the ages many groups of people have been badly treated because of their religion. The Mormons were one of these groups. Joseph Smith was killed by a mob in Illinois. But the church did not die. Brigham Young became the new leader.



Since the Mormons were being badly treated, Brigham Young decided to lead them still farther west. In July of 1847 he and his band reached Great Salt Lake. The region round about was desert. Without delay the Mormons began work to irrigate it and turn it into fertile farmland. By January over 1,600 Mormons had come to live in the valley of Great Salt Lake. Many came in covered wagons. Others, drawing loaded handcarts, came on foot.

There are now more than a million members of the Mormon Church. Salt Lake City's Mormon Temple and Tabernacle are famous all over the world.

The Mormon Church needs big sums of money to carry on all the kinds of work it does for the good of its people. The money needed is given by the members. Each one gives the church a tenth of all he earns. (See GREAT SALT LAKE; UTAH.)

MORSE, SAMUEL FINLEY BREESE (1791-1872) When the steamship "Sully" sailed from France for New York on Oct. 1, 1832, one of the passengers on board was Samuel F. B. Morse. Morse was an artist. He had just spent three years in Europe visiting art galleries and painting pictures. Now he was returning to New York. He planned to paint a great historical picture.

On the trip Morse heard one of the passengers, Charles T. Jackson, talk about an electromagnet he had with him. Electromagnets were very new then. In college Morse had been interested in electricity and magnetism. It is not surprising that he was interested in the new kind of magnet. One day someone asked Jackson how long it took electricity to flow through his magnet. Jackson answered that electricity travels so fast that it took almost no time at all. Morse then suggested that so fast a traveler might be used to carry messages. He set to work at once on this idea.

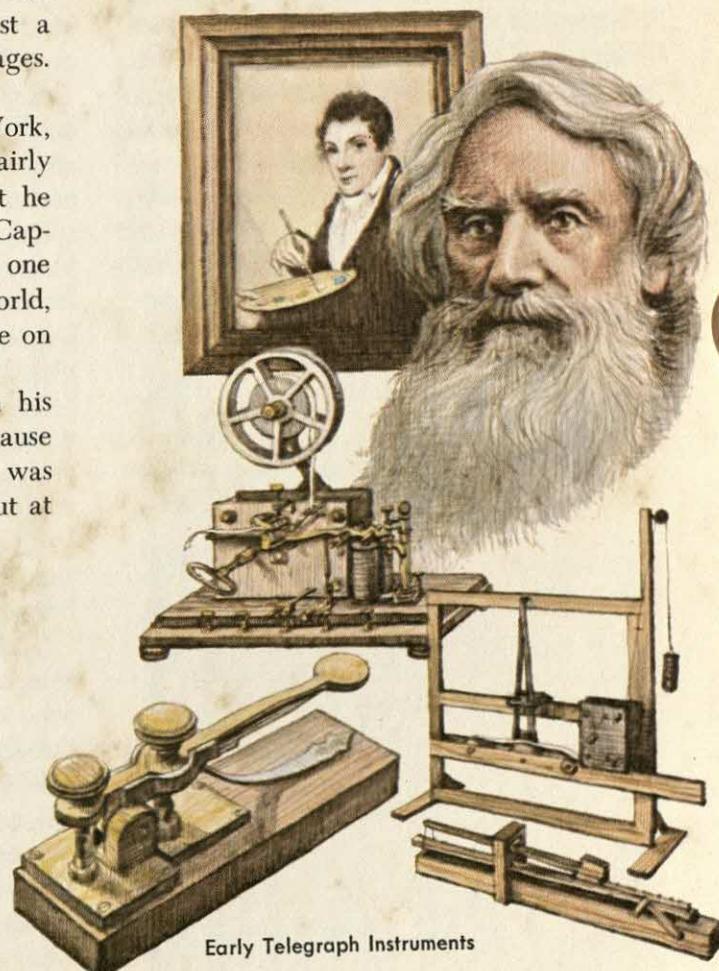
By the time he landed in New York, Morse had the plan for the telegraph fairly well worked out. As he left the boat he turned to the captain and said, "Well, Captain, should you hear of the telegraph one of these days as the wonder of the world, remember that the discovery was made on the good ship 'Sully.'"

Morse spent all his spare time on his new idea. The work was not easy because he had to do everything by hand. It was hard to buy even bare copper wire. But at

last, in 1835, he finished the first telegraph set. It worked well.

When he was sure his idea was a good one, Morse asked Congress to build a telegraph line from Washington to Baltimore. He also applied for a patent, which was not granted until 1840. He had to wait three more years for Congress to vote the money for the telegraph line. But the line was finally built. The first message sent over it was, "What hath God wrought?"

Morse was an excellent artist. He took an active part in politics, too. But it was his invention of the telegraph that made him famous. He lived to see more than 100,000 miles of telegraph line in the United States alone and to hear himself called one of the world's great inventors. (See COMMUNICATION; TELEGRAPH.)



THE INTERNATIONAL CODE

A	— —	R	— — —	1	— — — —
B	— — —	S	— — — —	2	— — — — —
C	— — — —	T	—	3	— — — — — —
D	— — — —	U	— — — —	4	— — — — — — —
E	—	V	— — — — —	5	— — — — — — — —
F	— — — —	W	— — — — —	6	— — — — — — — — —
G	— — —	X	— — — — — —	7	— — — — — — — — — —
H	— — — —	Y	— — — — — — —	8	— — — — — — — — — — —
I	— —	Z	— — — — — — — —	9	— — — — — — — — — — — —
J	— — — — —		— — — — — — — — —	0	— — — — — — — — — — — — —
K	— — — — —		— — — — — — — — — —		
L	— — — — —		— — — — — — — — — —		
M	— —	Call	— — —		
N	— —	Finish	— — — —		
O	— — —	Wait	— — — — —		
P	— — — —	Understand	— — — — —		
Q	— — — — —	Don't Understand	— — — — — —		

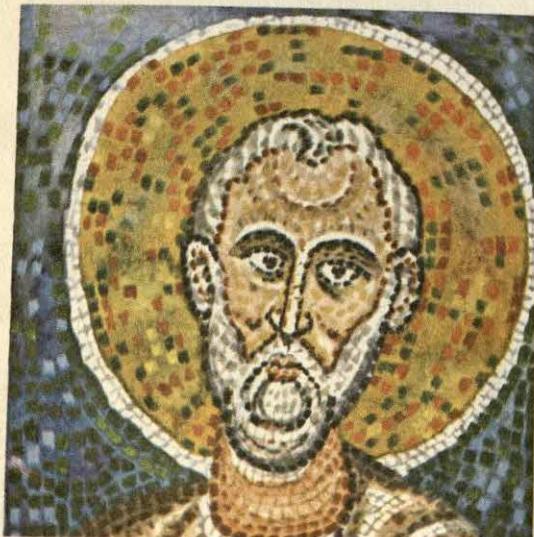
MOSAIC At least 2,000 years ago people were making pictures and designs out of tiny bits of colored stone. Pictures and designs made in this way are called mosaics. One mosaic may have thousands or even millions of tiny pieces in it. Making a mosaic takes a great deal of patience. The tiny pieces have to be set in some kind of cement, and each one must be set in just the right place.

Some of the finest early mosaics were made in northern Africa. In some of these mosaics there were such birds as swans, peacocks, and flamingos surrounded by leaves and flowers. They were very bright in color. Other mosaics were designs that looked like richly woven carpet.

When the little Roman city of Pompeii was dug out after it had been buried under lava and ashes for 18 centuries, some beautiful mosaics were found. One is a scene 17 feet long showing Alexander the Great during a battle. This mosaic looks like a painting. The tiny pieces are marble—red, yellow, olive-green, black, and white.

In the Middle Ages mosaics were made for churches. The tiny pieces were colored glass. They caught the light and sparkled like jewels. Some of the mosaics were pictures of Bible characters. In many the background was all one color, often gold.

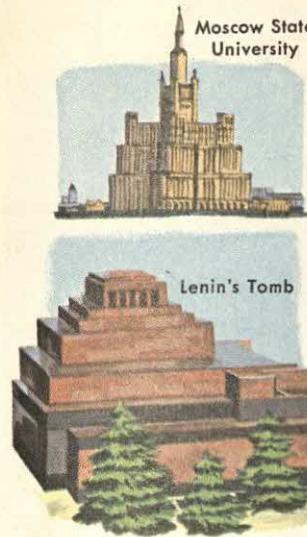
Many people call the Taj Mahal the most beautiful building in the world today. Its walls are decorated with mosaics. (See ALHAMBRA; POMPEII; TAJ MAHAL.)



MOSCOW Only five cities in the world are larger than Moscow. Over six million people live in this great city. Moscow is the capital of the Union of Soviet Socialist Republics and also of Soviet Russia, the largest republic of the Union. It is a center of transportation, industry, and education, as well as of government.

Eight hundred years ago Moscow was only a fortified village of log huts surrounded by a wooden wall. But it stood near many navigable rivers. In those days trade and travel followed rivers rather than roads. Moscow became a trading center. Except for rare times when Asiatic invaders holding southern Russia swept up to burn and plunder, Moscow was safe from enemies. Many refugees fled there. In time Moscow colonies spread out along the rivers. The grand dukes of Moscow, through colonies, trade, and war, annexed nearby and outlying districts of disunited Russia. By 1533 the Russian empire was fairly well established, with Moscow as its capital.

Today the Kremlin stands in the heart of Moscow, where the little medieval village once stood. Within the rose-brown walls of the Kremlin rise churches and cream-colored palaces. These were built by Russian emperors, the czars. Inside the Kremlin, too, are the U.S.S.R. government buildings. The vast Red Square, much used today for parades and public entertainments, is just east of the Kremlin. At one side of the



square is a great cathedral with colorful lily-bulb domes and many golden crosses.

Wide streets go out from the Kremlin walls like spokes from a wheel. On these streets there are modern business and apartment buildings, schools, hotels, and theaters. Gorki is one of the main streets.

Two world-famous theaters—the Moscow Art Theater and the Bolshoi (Great) Theater of Opera and Ballet—are in Moscow. The city has many large parks and playgrounds. Its subway has beautiful stations. Moscow State University in the suburbs has a tower over 30 stories high.

Among the many products of Moscow's industrial plants are automobiles, farm implements, steel, electrical and electronic goods, locomotives, textiles, and chemicals. Good river, rail, and air transportation has helped Moscow's industries to grow. Not far away are rich deposits of coal, iron, and other ores. Between the two world wars business boomed in the city, and modern building got its start. The population of Moscow doubled. (See BELLS; NAPOLEON; U.S.S.R.)

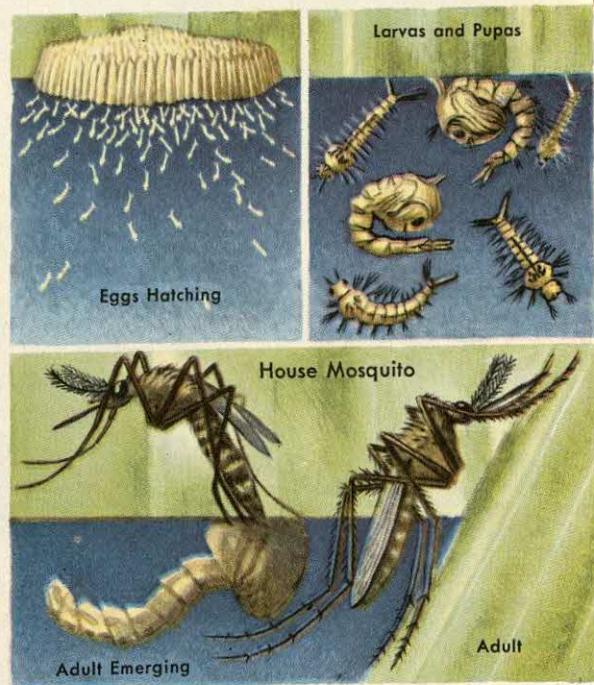
MOSQUITOES The pictures tell the story of how a common house mosquito grows up. A female mosquito lays hundreds of eggs at a time. She lays them on the surface of some still water. Perhaps it is a pond or a puddle or just a little water standing in a tin can. The eggs form a tiny

raft. Soon they hatch into wrigglers, or wiggletails. Each wriggler has a breathing tube that sticks up above the water as the baby insect hangs head down. After several days a wriggler changes to a pupa, which floats about, seemingly resting. But inside the pupa important changes are going on. In a few days a full-grown mosquito emerges and flies away.

For the rest of its life the mosquito lives in the air. If it is a male, it feeds on plant sap or fruit juice. If it is a female, it lives mostly on blood. When a mosquito bites a person, it is doing so simply to try to get something to eat.

All mosquitoes are tiny two-winged insects. The life stories of the 2,000 or so kinds are all very much the same.

The common house mosquito is a great nuisance. It can, moreover, do real harm by carrying diseases. Some of its relatives are notorious disease carriers. One of them carries malaria. Another carries yellow fever. No wonder scientists are always on the lookout for good ways of fighting mosquitoes. (See DISEASE GERMS; INSECT PESTS; MALARIA; PANAMA CANAL; REED, WALTER.)





Sphagnum, or Bog Moss

Haircap Moss

MOSSES Anyone who wishes to go on a moss hunt should go to a moist, shady place. Mosses are often found growing on damp soil, on tree trunks, on rocks, and on logs. Mosses are also found growing in ponds and at the bottoms of streams. They are never found, however, in salt water. These tiny plants may grow so close together that they make a green carpet.



Shaggy Moss



White-cushion Moss

Mosses do not have true roots, stems, or leaves. But they have parts which are like the roots, stems, and leaves of other plants except that they are much simpler. They do not, for instance, have any special water-carrying tubes.

Mosses do not have flowers or seeds. They must therefore have another way to make more plants like themselves. This is their way: The little green plants produce eggs, or female cells, and sperms, or male cells. When there is water enough, sperm cells swim to egg cells and join them. We say that the eggs are fertilized. Each fertilized egg then grows into a slender brown stalk. This stalk produces spores. Spores are very tiny; they are single cells. The spores that reach a good place to grow become new moss plants.

The pictures show four kinds of moss. There are many other kinds. Not many grow to be more than a few inches tall.

Some plants with moss in their names are not true mosses. Reindeer moss, for example, is not a moss, but a lichen. Long moss is a seed plant, a relative of the pineapple. It hangs down from the branches of many trees in the southern states. Irish moss is one of the red algae.

Some mosses are plant pioneers. Among them are the bog mosses. They fill up ponds and make them into dry land where grass and trees can grow. Bog mosses are sometimes called peat mosses because they form the fuel peat. Peat is the beginning stage of coal. (See PEAT; PLANT KINGDOM.)

MOTHER GOOSE Probably no one needs to be introduced to the characters in the pictures below. For they come from Mother Goose rhymes, and almost all children who speak English have heard these rhymes. Most of the boys and girls who look at these pictures could probably finish by heart the rhymes that go with them. They would know "Little Jack Horner," "Little Miss Muffet," "Jack and Jill," and many others just as well.

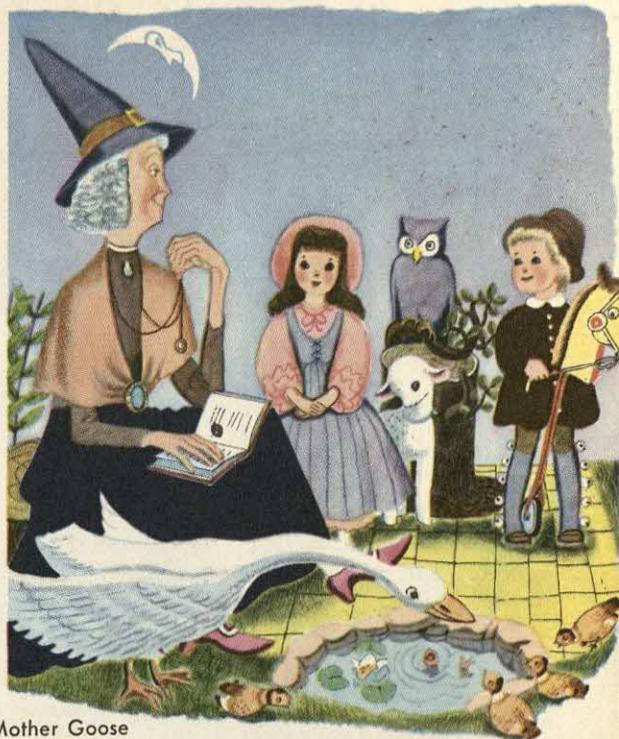
Our great-great-grandfathers and grandmothers and their great-great-grandfathers and grandmothers are almost sure to have heard these same Mother Goose rhymes when they were children. For these rhymes have been known for a very long time.

Was there ever a real Mother Goose who gave her name to these jingles? This is a question that no one can answer surely.

If you were to go to Boston you could see the place where a Mrs. Elizabeth Goose lived more than 200 years ago. This Mrs. Goose, some people like to think, was Mother Goose. The story is that she sang these rhymes as songs to her grandson and that the boy's father printed a book of them in Boston in 1719. There is a great deal of doubt about this story, for no one has been able to find a copy of the book.

Simple Simon
Met a pieman.

Jack, be nimble,
Jack, be quick.



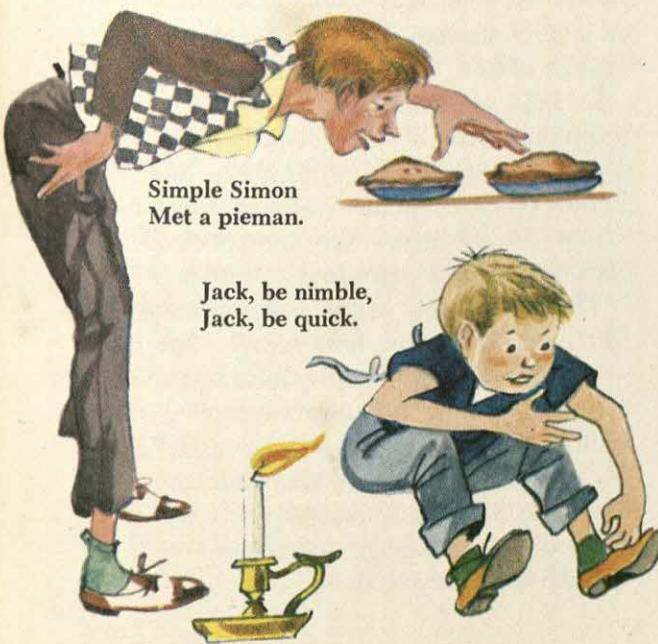
Mother Goose

One thing is certain. Few if any of the jingles we know as Mother Goose rhymes could have been written by Mrs. Goose of Boston. Most of them were known in England long before the days of Mrs. Goose.

Besides, the name Mother Goose had been used before. A Mother Goose book was printed in France 22 years earlier. But it was a book of fairy stories.

The first book of Mother Goose rhymes anyone knows surely about was published around 1780 in London by John Newbery. He collected some well-known rhymes and probably simply borrowed the name Mother Goose from the book of fairy tales. The Mother Goose book he published was not very large. It measured only $3\frac{3}{4}$ inches across and $2\frac{3}{4}$ inches from top to bottom.

Of course, it does not matter whether there ever really was a Mother Goose. Children will keep on liking Mother Goose jingles. New Mother Goose books will keep on appearing. The old familiar rhymes will be in them, but different artists will have different ideas of how the Mother Goose characters should look.





Phenakistoscope



Kinetoscope



Flip Pictures



Zoetrope

MOTION PICTURES At the back of each of our eyes there is a living screen called the retina. Light from what we are looking at enters the eye and forms a picture, or image, on this screen. Nerves carry the message from the eye to the brain, and we see. The retina holds each image for a small fraction of a second after it is no longer being formed on it. If, therefore, separate pictures are flashed very fast before our eyes, we do not see any break between them. This is the idea back of motion pictures.

A motion-picture projector throws about 24 pictures a second on a screen. They follow one another so fast that the changes in the positions of the things in the pictures give the impression of movement. A movie is made up of thousands of pictures printed on a long strip of film.

Of course, movie cameras must be able to take pictures one after another very fast. Today our cameras take about 24 pictures a second. There is not much difference between one picture and the next.

The story of motion pictures began in the 1830's with the invention in Europe of the phenakistoscope. It was made of two disks that whirled around fast. Things pictured on one disk seemed to move when viewed through slits in the other. Later, a somewhat similar device, the zoetrope, or "wheel of life," was a popular toy.

In 1872 an American, Leland Stanford, wanted to settle a wager about how a horse moved in a race. He arranged to have 12 cameras take 12 pictures, one after another. When the pictures were shown close together, the horse appeared to move.

Thomas Edison made a kinetoscope in 1891. It was a peep-show movie. One person at a time could see it by looking through a peephole. The pictures were on a strip of film 50 feet long. The show lasted only 13 seconds. The camera that took the pictures was called a kinetograph. It weighed as much as an upright piano and was, of course, too heavy to carry.

Soon short motion pictures began to appear as parts of vaudeville shows. Lecturers who gave travelogs often began or ended their talks with a short movie.

The first movie to tell a story was *The Great Train Robbery*. It was made in 1903. Soon other movies followed.

People liked movies so well that many motion-picture theaters were opened. The first ones were called nickelodeons. This word came from "nickel," the price charged, and the Greek word for theater.

Before long, motion pictures had become a great industry. In the United States Hollywood, Calif., became its center.

At first all the movies were silent films. Words were thrown on the screen from time to time, but the actors told most of the story with their actions.

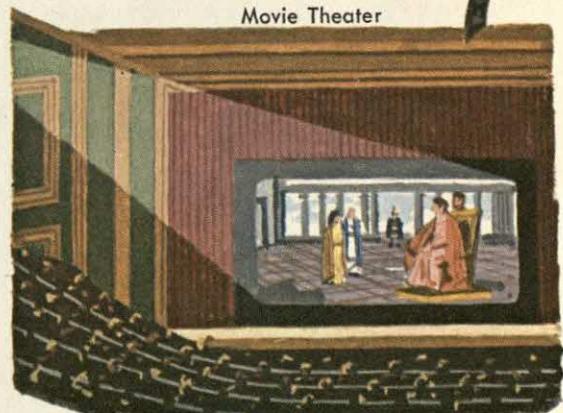
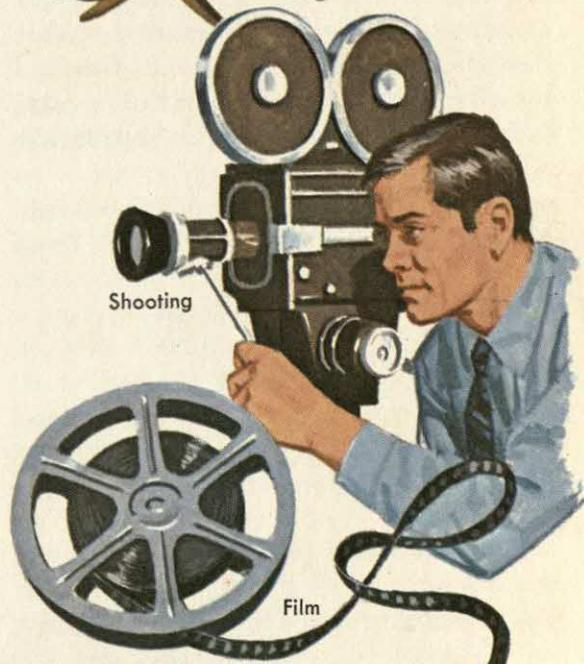
Then came sound pictures. The first picture with a musical score was *Don Juan*. It was put out by Warner Brothers in 1926. The first picture with spoken dialogue was *The Jazz Singer*, which Warner Brothers put out in 1927. Al Jolson was the chief actor, or star. The first all-talking picture was *Lights of New York*, made in 1928.

The next big improvement was making pictures in color. Then came wide- and curved-screen movies. Some of these have a 3-D (three-dimensional) effect. Some pictures are made in 3-D by using special cameras. These pictures must be looked at with special viewers.

In a motion-picture studio there are over 200 different kinds of work to be done. Screenplays must be written, stage sets built, and costumes made. Of course the pictures must be taken as the actors act out their parts. For a movie made from cartoons, thousands of pictures must be drawn. All films must be edited, too.

Some motion pictures have earned amazing sums of money. People, for instance, have paid over a hundred million dollars to see *Gone With the Wind*.

When television became popular, many people thought that it would mean the end



of motion pictures. Many movie theaters did close. But television and the movies soon found that they could work together. Many television channels depend on movies to provide much of their material.

Movies are not all for entertainment. The armed forces, industries, and schools use many of them for teaching. Movies can often show with pictures things that are difficult to explain in words.

There are home movies, too. Many people take movies of their own and show them at home with their own projectors. (See **CAMERA**; **EDISON, THOMAS**; **EYE**; **PHOTOGRAPHY**; **TELEVISION**.)

MOUND BUILDERS Scattered over the eastern half of the United States there are thousands of man-made mounds. Some of them look like low hills with flat or rounded tops. A famous one in Ohio is shaped like a huge writhing serpent.

Most of the mounds are burial mounds. In them many skeletons are found. There are countless relics, too, of the people who built them. There are tools and pieces of pottery, small statues and bits of jewelry. There are also beautifully carved stone pipes, mostly in the form of birds, fish, and other animals. Other mounds are platforms of earth built as bases for temples and other buildings.

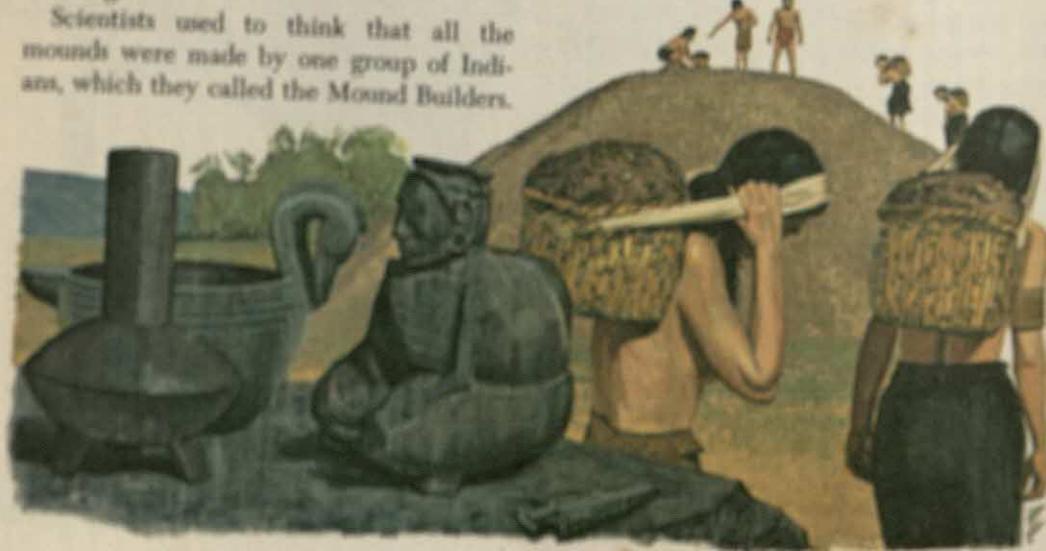
Scientists used to think that all the mounds were made by one group of Indians, which they called the Mound Builders.

Now we know that they were made by several different groups. The mounds were made at different times, too. Some of them were built a thousand years before the time of Christ. Others were not built till the time of the American colonies.

With big machines it is not hard to pile up great mounds of earth. But the Indian mound builders did not have any big machines. They had to carry the dirt for their mounds basketful by basketful. It must have been slow, hard work.

The tools and pottery found in some of the burial mounds show that the builders were highly civilized. The ornaments found in the mounds show that they were not stay-at-home people. There are pearls and conch shells from the Gulf of Mexico, copper and silver from Lake Superior, grizzly-bear teeth from the western mountains, and beautiful stones from many different parts of North America.

No one knows why, but the mounds built after about A.D. 500 were simpler than the earlier ones. Relics buried with the dead are fewer and less valuable. Something must have happened to change the trading practices and ways of living of the builders. What it was may always be a mystery. (See **INDIANS, AMERICAN**.)





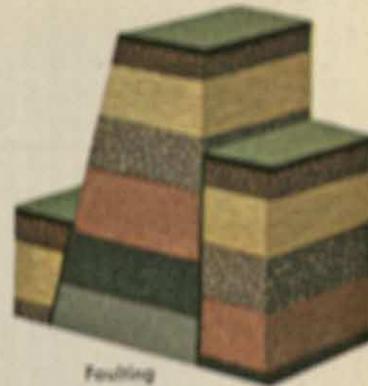
Doming by Intrusion



Volcanic Eruption



Folding



Faulting

MOUNTAINS The world's highest mountains look very much alike. But if these mountains could tell their stories, the stories would not all be the same. For some high mountains are volcanoes. Others were made in other ways.

Geologists can read the story of any mountain from the rocks it is made of. Of course, no one can slice down through a mountain to look at the rocks. But rivers and streams do a great deal of slicing for the geologists. And the rocks that show at the surface on the sides of the mountain tell much of the mountain's story.

One diagram above shows a volcano. A volcano is built up by hot, liquid rock from deep in the earth. Sometimes the hot rock is shot so high into the air that it hardens into cinders or ash before it falls.

Another diagram shows how a mountain may be formed by folding. In olden times people would have laughed at the idea that layers of solid rock could be pushed up into a great fold. They did laugh at Xenophanes, the first person who had this idea.

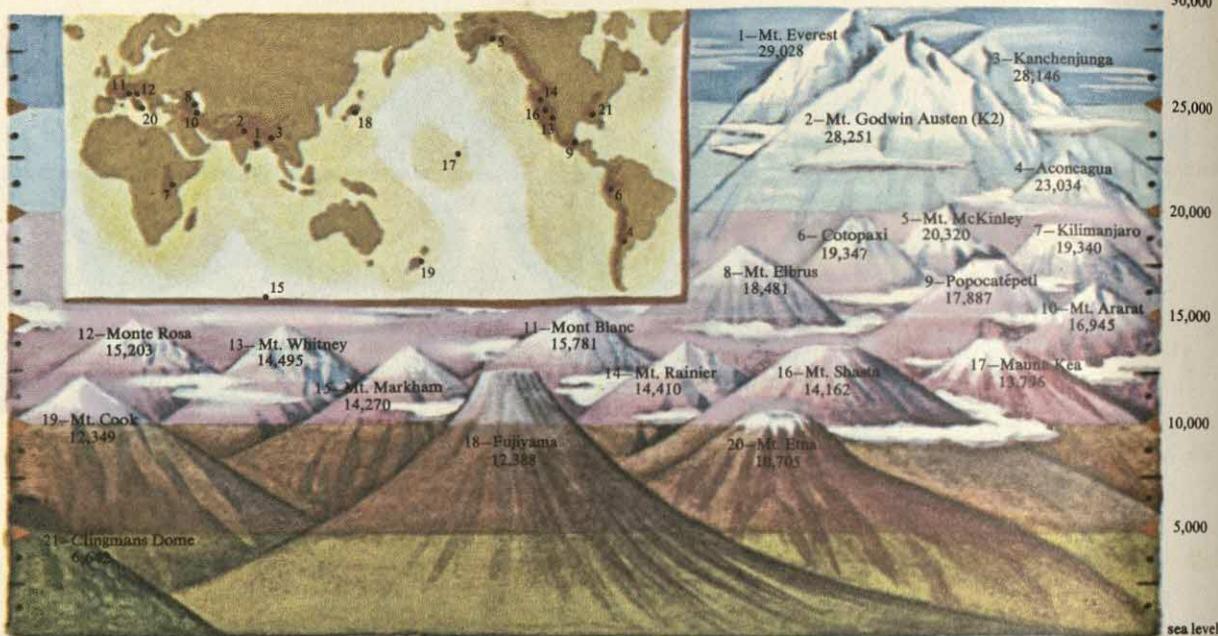
Xenophanes was a Greek who lived about 2,500 years ago. One day he found some

seashells at the top of a mountain in Greece. They were not loose shells. Instead they were all cemented together into rock. "How," Xenophanes asked himself, "can rock made of seashells be at the top of a mountain?" The only answer he could think of was that the top of the mountain had once been the bottom of a sea. We know now that he was right. The floor of the sea had been folded up to form mountains. Many mountains are folded mountains.

The other two diagrams show a dome mountain and a block mountain. When hot, liquid rock deep in the earth pushes up layers of rock near the surface into a big "blister," a dome mountain is made. A block mountain is made when masses of rock move up or down along cracks, or faults, in the rocks of the earth's crust.

Usually mountain building goes on slowly. Many people probably are now living without knowing it on land that is being pushed up into mountains. The upward push goes on far too slowly to be noticed.

Mountains are not usually made one at a time. Only volcanoes and mountains pushed up by pockets of hot rock are. As a rule, a long fold or ridge is pushed up. It is carved by wind and water into mountain peaks. The mountains carved out of a great fold or ridge make a mountain range. The most famous ranges are the Alps, the Rockies, the Andes, and the Himalayas.



Mountains do not last forever. Even while a mountain is being made, wind and water are tearing it down. Often ice helps in the tearing down. In many places on the earth there are signs of mountains that are no longer there. But tearing down a mountain is slow work. Most of the mountains of today are millions of years old.

It is not easy to measure exactly how tall a mountain is. When we say that a mountain is two miles high we do not mean that it rises two miles above the land around it. We mean instead that the top of the mountain is two miles above sea level. Besides, some of the highest mountains are in parts of the world hard to reach. Every once in a while there is a newspaper story about the discovery of a new high mountain peak. As far as anyone knows, the very highest mountain is Mount Everest in the Himalayas.

The chart above and the list in the next column tell how some of the other famous peaks compare with Everest in height. Those starred in the list are the highest mountains of their continents.

Not all mountains are on land. Some rise from the floor of the sea. Their tops may form islands. The island of Hawaii,

MOUNTAIN	RANGE	COUNTRY OR STATE	HEIGHT
*Everest	Himalayas	Nepal-Tibet	29,028
Tirich Mir	Hindu Kush	Pakistan	25,236
*Aconcagua	Andes	Argentina	23,034
Illampu	Andes	Bolivia	21,276
*McKinley	Alaska	Alaska	20,320
Logan	St. Elias	Canada	19,850
*Kilimanjaro		Tanzania	19,340
Orizaba (Citlaltepetl)		Mexico	18,700
*Elbrus	Caucasus	U.S.S.R.	18,481
Kenya		Kenya	17,058
Stanley	Ruwenzori (Mountains of the Moon)	Uganda-Rep. of Congo	16,763
Matterhorn	Alps	Switzerland-Italy	14,690
Elbert	Rockies	Colorado	14,431
Longs Peak	Rockies	Colorado	14,255
Pikes Peak	Rockies	Colorado	14,110
Jungfrau	Alps	Switzerland	13,642
*Erebus		Antarctica	12,450
Hood	Cascades	Oregon	11,245
*Kosciusko	Australian Alps	Australia	7,316
Mitchell	Black Mountains	North Carolina	6,684
Washington	White Mountains	New Hampshire	6,288
Rushmore	Black Hills	North Dakota	6,200
Greylock	Berkshires	Massachusetts	3,491

for instance, is the top of four huge volcanic mountains that rise from the floor of the Pacific Ocean. The Azores are peaks of a long chain of mountains in the Atlantic. (See ALPS; ANDES; APPALACHIANS; EARTH HISTORY; HIMALAYAS; ROCKS; ROCKY MOUNTAINS; VOLCANO.)

MOZART, WOLFGANG AMADEUS (1756-1791) One of the greatest musicians of all time was born in Salzburg, Austria. He was often called the "Wonder Boy." His father Leopold, also a musician, was a composer and violinist at the Salzburg court. When Wolfgang was three years old he began to show great interest in music. One day after listening to his older sister's music lesson he went to the clavier (an early kind of piano) and played one of his sister's pieces. His father realized that Wolfgang had great talent. When the boy was four he began to take music lessons. He learned very quickly and at five not only played well but had already done some composing.

From the time he was six, Wolfgang's father took him and his sister on tours of the leading cities of Europe. They went first to Munich, where the Mozart children gave many concerts, then to Vienna, and later to Brussels, Paris, and London. People were amazed at these musical children. Once while they were playing in Vienna the emperor asked Wolfgang if he could play as well if the keys were covered by a cloth. Wolfgang said nothing. But after the keys were covered, people found that he could play just as beautifully as he did with the keys uncovered. The happy, gifted child was loved by everyone. One day at the palace he slipped and fell on the polished floor. The little daughter of the emperor ran and helped him up. Wolfgang said to her, "Oh, you are so kind! Someday I shall marry you." The little girl was Marie Antoinette, later the queen of France.

Wolfgang played the organ and violin as well as the clavier, although he never had any lessons on these two instruments. When he was 13 he went to Italy, where he gave concerts. In Rome he was invited to listen to some special music that had not yet been published. He was not allowed to see the music. Wolfgang listened to it, then went to his room and wrote the music from memory. No one could believe that such a thing was possible. It was while he was in

Rome that the pope conferred upon him the Order of the Golden Spur. This meant that at 13 he was a knight.

After 13 years of composing music and giving concerts all over Europe, Mozart returned to Salzburg but soon went to Vienna. He married and tried to earn a living by composing and giving lessons. People were often enthusiastic about his music, but he received little money. He lived in poverty for the rest of his life.

Mozart spent long hours each day at his work. He was unable to stand working so hard, and in his 35th year his health failed. It was in his last year that he wrote one of his greatest works, the *Requiem Mass*. He did not live to finish it. One of his pupils finished it after his death. No one knows exactly where Mozart was buried. Some years after his death a monument was erected to him in Vienna.

Mozart was one of the very few composers who mastered both the symphony and the opera. *The Magic Flute*, *The Marriage of Figaro*, and *Don Giovanni* are his three greatest and best-known operas.

He wrote 48 symphonies, the first at the age of eight. The "Jupiter" symphony, which he wrote in 15 days, is considered his finest. He composed concertos, choral music, orchestral and chamber music, and a great many smaller compositions. (See COMPOSERS; MUSIC; OPERA.)





MUMMIES The ancient Egyptians believed that a person's body should be kept from decaying after death. The body must be kept as it was so that the soul which had left it could return.

To keep a dead body from decaying, the Egyptians used chemicals which dried it. They dried it very much as we now dry fish or beef. Then they wrapped it in layer after layer of linen. Several hundred yards of linen were needed. The layers of linen were held together with coatings of resin. A body that has been treated in this way is called a mummy.

Mummifying a body took about 70 days. During that time woodworkers were busy making coffins, for the mummy of an important person had more than one. The coffins fitted one inside another. The innermost coffins were often beautifully painted.

Many museums now have Egyptian mummies. These mummies look very much as they must have looked centuries ago. The Egyptians' ways of keeping bodies from decaying were certainly good ones.

Not all Egyptian mummies were mummies of human beings. There are mummies of almost every kind of animal held sacred by the Egyptians. Among them are cat, gazelle, bull, owl, and crocodile mummies.

There are mummies from other lands, too. In Peru and nearby countries, for instance, numerous Inca mummies have been found. But to most people the word mummy means an Egyptian mummy. (See EGYPT; INCAS; PYRAMIDS.)

MUMPS A person with mumps looks funny. At least one side of his face is badly swollen; perhaps both sides are. But you may be certain that he does not think he is having fun. His face is sure to hurt, and he is likely to have a fever and to feel very much like staying in bed.

Mumps is caused by a tiny virus. The virus gets into some of the glands that produce the watery saliva in our mouths and makes these glands swell. Mumps is contagious. The virus travels easily from person to person. A person comes down with the disease anywhere from 11 to 28 days after he has been exposed.

Sometimes a person who thinks he may be coming down with mumps tests himself by trying to eat a pickle. If he has mumps, the sourness of the pickle is likely to hurt him a great deal. But eating a pickle is not at all a sure test.

Mumps is called one of the children's diseases because most of the people who have it are between 5 and 15. But older people sometimes have it. No one, however, is likely to have mumps a second time.

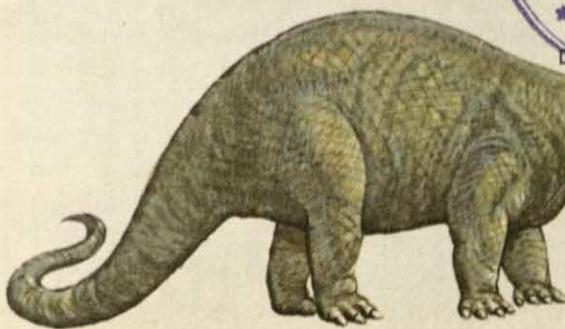
Mumps is not likely to be serious if the patient stays quiet and is well taken care of. It may be serious otherwise, especially for boys over 15. The fever lasts from three to seven days. The swelling may last longer. Anyone who has had mumps should stay at home till all the swelling has disappeared. There is a mumps vaccine, but it is seldom used. (See DISEASE GERMS; DISEASES; VIRUS.)

MUSEUM Where could you see the skeleton of a dinosaur? Where would you go to look for a painting by Rembrandt? Where could you find jewelry made in Egypt 5,000 years ago? Where would you be likely to find a section of a tree that had lived for more than 1,000 years? The answer to all these questions is the same. It is, "A museum." Museums are storehouses of fascinating things.

Most of the great cities of the world have at least one museum. Many cities have more than one. There are several kinds of museums. The most common are art museums, science museums, and historical museums. In Washington, D.C., the United States government has a very large museum called the Smithsonian Institution. It is really a group of museums. So is England's famous British Museum in London.

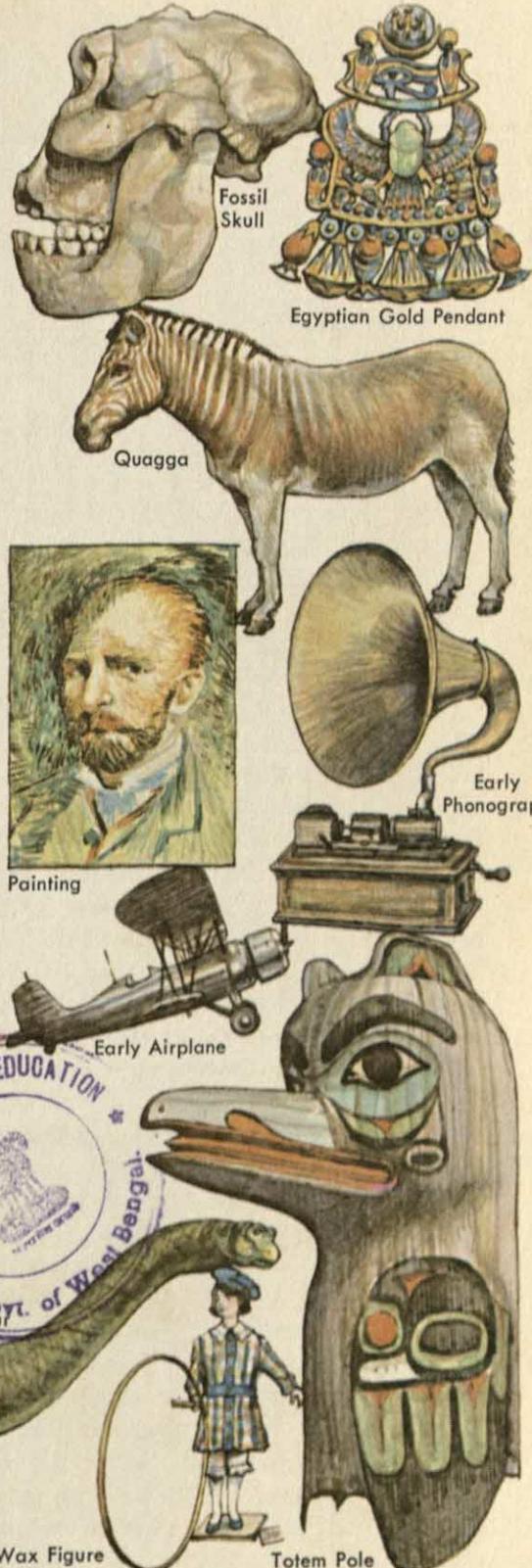
The pictures show a few of the things you might see in museums. There are thousands and thousands of other things in museums that are just as much worth seeing. When we wish to say that anything is especially rare or beautiful or interesting, we often say, "It is a museum piece."

A museum may send out expeditions to places all over the world to gather new material. Experts study the material they gather and plan exhibits. They do a great deal of talking and writing about the things they learn and the exhibits they prepare. In addition, they go over many things sent to them and decide whether the things are worth keeping. They also answer questions by the thousands. (See MUMMIES; NATIONAL PARKS; PLANETARIUM.)



Dinosaur

Wax Figure

Fossil
Skull

Egyptian Gold Pendant

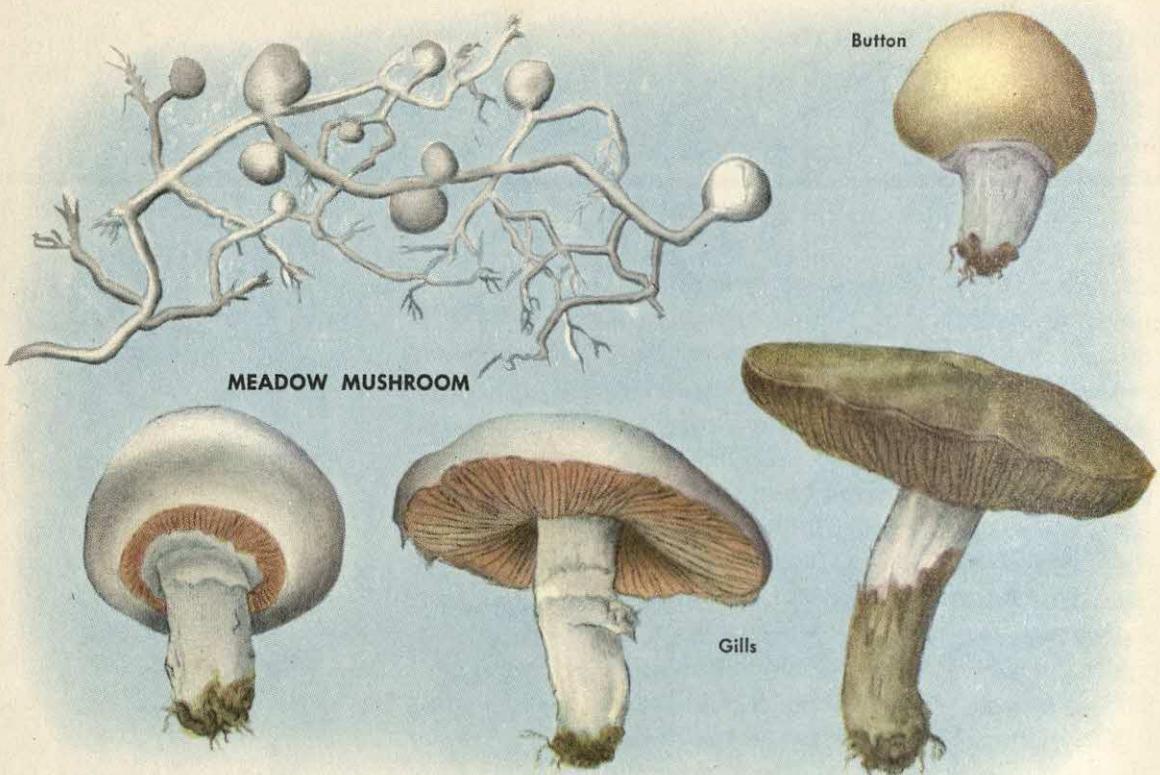
Quagga

Early
Phonograph

Painting

Early Airplane

Totem Pole



MUSHROOMS No one ever picked a bouquet of mushroom flowers or planted mushroom seeds. Mushrooms have neither flowers nor seeds. New plants start from spores instead of from seeds. The spores are not formed in flowers. Mushrooms have no leaves or roots, either.

A mushroom plant is made up of white threads and of parts that bear the spores. The white threads form the mycelium (my SEE lee um). This part of the plant is usually hidden. The spore-bearing parts are what we see of the plant. We often use the word "mushrooms" to mean just these parts instead of the whole plant.

Green plants make food for themselves. Mushrooms get their food in another way. They use food which green plants have made. They take it from living or dead plants or from decaying plant material in the soil. The threadlike mycelium takes in the ready-made food.

Mushrooms grow best in warm, damp places. The mycelium of the common meadow mushroom may be spread through

the soil but not be growing, because the weather is not warm enough. Then suddenly on a warm, damp day mushrooms pop up as if by magic. They come through the ground looking like little buttons. They grow fast into full-sized mushrooms.

A single mushroom produces many spores—so many of them that it is not possible to count them. They are so tiny that they look like dust. One kind of mushroom is called a puffball because it is ball-shaped and its spores puff out in clouds that look like smoke. One giant puffball may have trillions of spores.

Some kinds of mushrooms bear their spores on gills. The meadow mushroom and all the others pictured here are gill mushrooms. The gills hang like many tiny curtains close together from under the "umbrella" of the mushroom. Some other kinds of mushrooms have their spores in little tubes. The common shelf mushroom, which grows on tree trunks, is one of them. Its pores—the openings into the tubes—are so tiny that they are like pinholes. Puffballs

have their many spores shut up inside them. Some other kinds of mushrooms have their spores on "teeth," and still others have them on branches.

Many kinds of mushrooms are good to eat, but there are also many kinds which are poisonous. Only experts should gather mushrooms for food. There is no safe rule telling what wild mushrooms are edible.

The mushrooms we buy are specially raised. Growers plant chunks of mushroom mycelium, or spawn, in rich, moist soil.

Mushrooms belong to the group of plants called fungi. There are many, many kinds. If we collected a new kind of mushroom every day, it would take more than ten years to collect one of each kind. Some of them have unusual names—inky cap, horn of plenty, coral, bird's nest, parasol, death angel, beefsteak, and jack-o'-lantern. They get most of their odd names from their shape or their color. It is easy to guess how those called stinkhorns get their name. (See FUNGI; POISONOUS PLANTS.)



Gypsy Mushroom



Brownie Cap



Orange Lactar



Shaggy Mane



MUSIC Early man heard musical sounds about him. The singing of birds, the murmuring of brooks, and the lapping of waves on a shore were pleasant to listen to.

Musical sounds, like all other sounds, are made by moving something rapidly back and forth. Such movement is called vibration. In musical sounds the vibrations are regular. In noise they are not.

No one knows when, but at some time very long ago, people got the idea of making music themselves. They found that with music they could express their feelings as well as make sounds that were pleasant to hear.

Rhythm, melody, and harmony are important parts of music today. Rhythm and melody are much older than harmony. Rhythm is the accent, or beat, in the flow of sound. Melody is the tunefulness. Harmony has to do with the sounding of different notes at the same time.

Thousands of years ago people were singing simple melodies as they worked and played. The best songs were not written down but were remembered and handed down from one generation to another.

Perhaps as long ago such simple instruments as pipes and drums appeared. The drums helped with the rhythm of dances. They could not produce melody. But a pipe that played two or more notes could.

By the time of the early Greeks there were stringed instruments that helped singers get a good effect. The Greeks chanted their poetry while the harp and the lyre were played.

Music came to be so important in the lives of the people of early times that formal music was bound to appear. Formal music is music that has been specially composed for some purpose. The composer writes the music down in some way. No one can tell when and where music was first composed and written down. But we do know that the Greeks wrote music with the letters of their alphabet. Writing in notes like those of today came much later.

After music began to be composed, rules for composers to follow were gradually worked out. Different rules were worked out in various parts of the world. Music from some foreign lands sounds strange to us just as our music sounds strange to the people of some foreign lands.

The first composed music was for voices. Earlier songs had been sung in unison; everyone, that is, sang the same melody. When composers began composing songs, they began adding other melodies to the main melody. Such writing for different parts, or voices, became known as polyphonic music—music of many sounds. Harmony was now in the picture.

Another kind of part-singing was the round. In a round there is only one melody, but singers come in with the melody at different times. The earliest round we know of is the English "Sumer is icumen in." It was written about 700 years ago. Perhaps the round that children today know best is "Three Blind Mice."

Much of the work of early European composers was sacred music for the church. But there were also gay songs. Some of them were called madrigals.

Songs people made up as they worked or played came to be called folk songs. The earliest American folk melodies were those of the Indians. Later came songs of the American Negro, the mountain folk, and the western cowboys. But all these, except perhaps those of the Indians, came thousands of years after the first folk songs.

Other early songs were religious songs. They came about much as folk songs did. As they worshiped their gods, people expressed their feelings in song.

Writing music for instruments began about 400 years ago. Violins and keyboard instruments became popular. From that time on people developed many kinds of compositions. Many different groups were formed to perform them. There came to be choirs, opera companies, string quartets, symphony orchestras, and many others

besides. But of course not all the music composed was for groups. Great soloists appeared—singers, violinists, pianists, cellists, and so on.

Among the many kinds of musical pieces are these:

Symphony—a long work for a symphony orchestra. Usually written in several parts, or movements.

Oratorio—usually sacred, written for soloists and a choir of many voices. Has an orchestral accompaniment. There is no scenery or action.

Opera—drama set to music for both voices and instruments. Usually several solo parts. Action and scenery important.

Sonata—a long work written for one or two instruments. It is usually in three or more movements.

Concerto—usually for one solo instrument but with a background for orchestra.

Chamber music—written for a few instruments and played to small audiences.

Suite—a series of rather short dance melodies written for instruments.

Cantata—like a short oratorio, but usually not sacred.

Anthem—a song or hymn written for a church choir.

Fugue—an elaborate kind of round for voices or instruments.

New ideas and the spirit of the age we are living in are reflected in the music of today. Modern composers have introduced new combinations of tones that in the past would have been called unmusical. Jazz, like much other American music heard today, has a strong, unusual rhythm.

Records, radio, and television have made it possible nowadays for people, even if they live far from any city, to hear famous singers and great orchestras. Music is taught in schools; children learn to know the great compositions. Some of us are just listeners, but plenty of opportunities exist for the many people who can sing or play an instrument well.

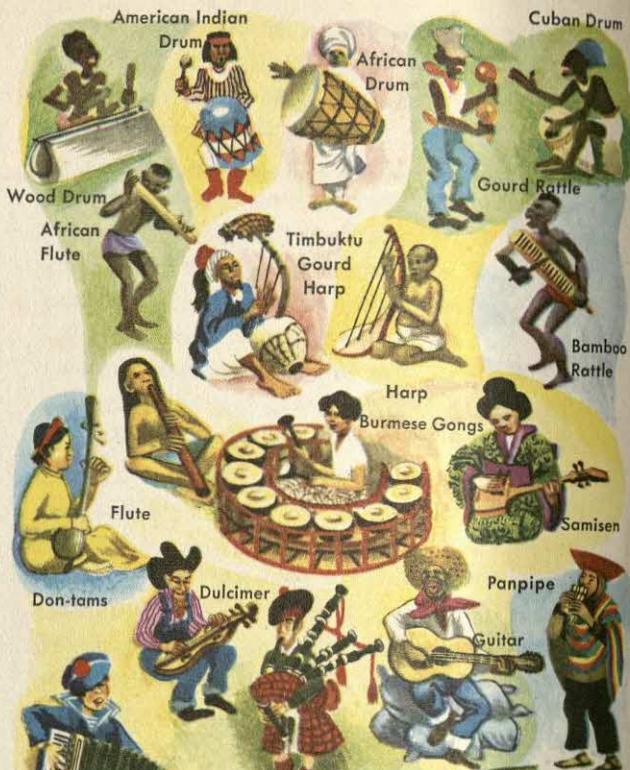
Music is sometimes called a universal language. In music there are not the barriers there are with spoken languages. A composer who cannot speak a single word of our language can still make us feel joy and pride, exaltation and despair, peace and mystery through his music. (See BAND; COMPOSERS; DRUMS; MUSICAL INSTRUMENTS; OPERA; OPERETTA; ORCHESTRA; PERCUSSION INSTRUMENTS; WIND INSTRUMENTS.)

MUSICAL INSTRUMENTS People are born with built-in musical instruments—their voice boxes. But not even our very early ancestors were satisfied with having just their voices to make music. Thousands of years ago they learned to make musical instruments out of reeds, hollow logs, and other things they found around them.

The pictures on this page show some of the many kinds of musical instruments. Some kinds of instruments have been played for thousands of years. Others have been developed in recent times.

Most musical instruments belong in one or another of these three groups: wind instruments, stringed instruments, and percussion instruments. In every musical instrument there must be something which can be set to moving back and forth, or vibrating. Unless something is vibrating, no sound comes from the instrument.

Wind instruments are all played by setting the air inside them to vibrating. As





Old-fashioned stringed instruments, like modern ones, could be either plucked or bowed.



Woodwind instruments include flutes, piccolos, clarinets, oboes, and saxophones.

As a rule the player blows into them. Their name tells that stringed instruments have strings. The player plucks the strings with his fingers or draws a bow across them. Percussion instruments are played by striking them. It is easy to sort out most of the instruments in the pictures into their proper places in these three groups.

There are a few instruments that do not fit exactly into any one of these groups. The piano is a good example. It has many strings, but it is played by making little felt hammers hit the strings. Thus it is both a percussion and a stringed instrument.

In most bands only wind and percussion instruments are used. Orchestras use stringed instruments, too. (See BAND; ORCHESTRA; PERCUSSION INSTRUMENTS; PIANO; SOUND; STRINGED INSTRUMENTS; WIND INSTRUMENTS.)

MUSIC BOX The little music boxes in the picture below were made in Switzerland. Switzerland is noted for its music boxes. Some music boxes have little figures that dance to the music.

A small metal cylinder is an important part of many music boxes. The cylinder has "pins" sticking up from it. A spring makes the cylinder turn around. As it turns, the pins strike the teeth of a metal comb. Each tooth gives off a certain note when it is struck. As the teeth are struck, a tune is played. Of course, the pins must be in exactly the right place on the cylinder. A music box with a cylinder has its tunes built in.

Some music boxes have metal disks instead of cylinders. Little tabs projecting downward from the disk strike the comb beneath as the disk turns around. Before the phonograph was invented, music boxes were made with disks that could be changed like phonograph records.

Music boxes have a tinkly sound. And sometimes it is hard to tell what tune is being played. But many people think that music boxes are fun. Collecting music boxes, in fact, is a rather common hobby.





Ojeeb Annung and the wolverine jumped into the sky and sent summer to the earth.

MYTHS AND LEGENDS Before the days of science people in many different parts of the world made up stories to explain the world as they saw it. They told stories to explain why the seasons change, why birds migrate, why robins have red breasts, why each group of stars is in the sky, and many, many other such things. Stories of this kind are called myths. They are not true. But they show that the people who made them up were really trying to understand the world around them.

There are many Indian myths about nature. The picture on the opposite page illustrates one of them. It is a myth told by the Ojibway Indians.

Ojeeb Annung, so the myth says, was a famous hunter. He had the power of changing himself into a fisher, an animal of the forest, whenever he wished.

The hunter's son also wanted to be a great hunter, but the land where he lived was too cold much of the time. The boy's hands were so cold that he could not fit his arrows into his bow. He begged his father to make summer come. His father promised, although he knew it would be hard.

The hunter climbed to the top of a tall mountain. With him went his friends the otter, the beaver, the lynx, the badger, and the wolverine. At the top of the mountain each animal tried to jump high enough to break a hole in the sky. The wolverine finally succeeded. The hunter and the wolverine climbed up through the hole. There they found a land of flowers and birds and summer weather. The sky people were nowhere to be seen. In some of their lodges there were many cages of birds. The hunter knew that, if he released these birds, they would fly through the hole in the sky and carry summer to the earth.

He and the wolverine went about opening cages. The birds flew out and down to earth. They made such a noise that the sky people heard it from far away and hurried to close the hole in the sky. Ojeeb Annung changed himself into a fisher,

but the sky people shot him with their arrows. They stretched him out in the sky, where he can be seen to this day as the constellation known now as the Great Bear.

In this myth the Indians explained what brings summer. They explained, too, why the Great Bear is in the sky.

Not all myths are about nature. Many myths are about gods and goddesses. They are closely tied up with the religion of the people who first told them. Many people of today know the names of the Greek, Roman, and Norse gods and goddesses because they have read myths about them.

Peoples all over the world have told wonderful stories of their past. They have invented great heroes and made them do marvelous deeds. The stories have been handed down from generation to generation. Such stories are called legends.

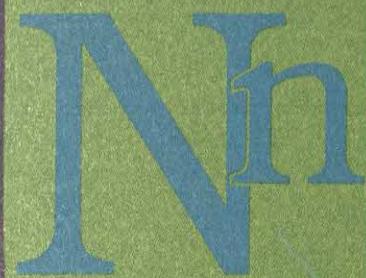
Many legends have some truth in them. Perhaps some have a great deal, but many of them come from so far back in the past that no one can be sure. The stories of Roland, Robin Hood, King Arthur, and William Tell are well-known legends.

Paul Bunyan is one of the legendary heroes of America. Why aren't there more trees in the Dakotas? Paul Bunyan, the legends say, knocked them all down in a fight. Why is Kansas flat? Paul Bunyan and his blue ox, Babe, leveled it to make corn planting easy. What gave the Grand Canyon its beautiful colors? Paul Bunyan painted it. Who made the Great Lakes? Paul Bunyan did, so that Babe would have plenty of water to drink.

No one can tell how the Paul Bunyan stories began, for, so far as anyone knows, there never was a real Paul Bunyan. Once the stories of his strength were started, however, lumberjacks took him for their hero and made up more tall tales about him. In Bemidji, Minn., there is a huge statue of Paul Bunyan. Beside it is a statue of Babe. (See GREEK MYTHS; NORSE GODS AND GODDESSES; ROMAN GODS AND GODDESSES.) (See chart, next page.)

	NORSE	ROMAN	GREEK	EGYPTIAN	BABYLONIAN
SUPREME GOD	Woden; Frigg	Jupiter, or Jove; Juno	Zeus; Hera	Amon-Re	Marduk; Sharpanit
CREATION	Ymir; Woden			Ptah	Apsu; Marduk
SKY	Frigg	Jupiter	Uranus; Zeus	Nut	Anu
SUN		Apollo	Helios; Apollo	Re	Shamash
MOON		Diana	Artemis	Thoth	Sin
EARTH	Sif	Tellus	Gaea	Geb	Enlil
AIR				Shu	Enlil
FIRE	Hoenir	Vulcan; Vesta	Hephaestus; Hestia		Girru
SEA AND WATER	Niord	Neptune	Poseidon	Tefnut	Ea
RAIN	Thor	Jupiter	Zeus		Marduk
LIGHT	Balder	Apollo	Apollo	Show	Nusku
THUNDER	Thor	Jupiter	Zeus		Adad
WIND			Aeolus		Enlil
DAWN		Aurora	Eos		
MOTHER GODDESS	Nerthus	Venus	Aphrodite	Isis	Ishtar
FERTILITY	Frey	Bona Dea, or Damia	Rhea	Osiris	Ishtar
HARVESTS	Balder	Saturn	Cronos		
VEGETATION	Balder	Ceres	Demeter; Adonis	Osiris	Tammuz
DEATH	Hel	Pluto, or Dis	Hades, or Pluto	Anubis; Osiris	Nergal
MUSIC AND POETRY	Bragi	Apollo	Apollo	Thoth	
WISDOM	Mimir; Woden	Minerva	Athena	Thoth	Nabu
MAGIC	Woden	Mercury	Hermes	Thoth	Ea
WAR	Tiu	Mars; Bellona; Minerva	Ares; Athena	Onuris	Ira
LOVE	Freya	Cupid; Venus	Eros; Aphrodite	Hathor	Mylitta
BEAUTY	Freya	Venus	Aphrodite		Ishtar
MESSENGER	Hermod	Mercury	Hermes		
HEALING	Eira	Apollo	Apollo		Gula
HUNTING	Uller	Diana	Artemis		Beltis
WINE		Liber; Bacchus	Dionysus, or Bacchus		
DIVINE SMITH AND ARTIFICER	Mimir	Vulcan	Hephaestus		





The letter *N* began as the picture of a snake, . The picture is found often in the hieroglyphic writing of the ancient Egyptians. The makers of the first alphabet chose it to stand for a single sound.

The shape of the letter changed as the alphabet went traveling. The Phoenicians made it bend sharply: . The Greeks changed it to look like this: . In the Latin alphabet the Romans used, the letter became the *N* we know.

N stands for one sound in English, the sound it has in *man*. Sometimes it is silent, as in *hymn*.

NAIL A nail is a stick of stout metal made for fastening things together. As a rule one end is broadened into a head and the other end tapered to a point. Usually the stick is round, but it may be square.

Before 1786 all nails were made by hand. In 1786 a nail-making machine was invented. Now there are machines that can turn out a thousand nails a minute. Wire is fed into these machines. It passes through rollers that straighten it and grippers that hold it tight while the end is struck to flatten it and form a head. The wire moves on just enough for cutters coming together to cut and taper a nail of the right length. The nails are later polished.

Handmade nails were made mostly of wrought iron. Machine-made nails are made mostly of steel, but there are iron, copper, brass, and aluminum nails, too, as well as special-purpose nails of certain alloys. Nails made of a carbon-steel alloy, for instance, can be driven into brick.

There are nails of many different shapes and sizes. Some have very small heads or almost none. Some have blunt ends. The nails called staples are U-shaped and both ends are pointed. For every use of nails there is one kind that is best.

The word "penny" is used in telling the size of some nails. A 3-penny nail is $1\frac{1}{4}$ inches long. A 4-penny nail is $1\frac{1}{2}$ inches long. A 10-penny nail is 3 inches long. Longer nails are sometimes called spikes. Tacks and brads are less than an inch.

Nails are usually sold by weight. The smaller ones are more expensive per pound than the big ones. It is easy to see why. There are more to the pound if the nails are small, and it is as much work to make a one-inch nail as a six-inch one.



NAILS AND CLAWS We carry with us 20 nails all the time. They are not at all like the nails we buy. Instead they are scalelike—oval and thin. These nails, of course, are our fingernails and toenails.

Our nails are very helpful—much more helpful than most of us realize. Our fingernails help us pick up things and do fine work. They also protect the ends of our fingers. The ends of our toes are protected by our toenails.

Nails grow from a special layer of skin. If they are healthy, they keep growing so that, even with the wear and tear on them, they are always long enough to protect our fingertips and the ends of our toes. Usually, in fact, we do not wear our nails off as fast as they grow, and they have to be filed or clipped to keep them from being so long they are a nuisance.

Our fingernails have a great deal to do with our looks. Some people go to beauty shops often for manicures. The word manicure comes from two Latin words that mean "hand" and "care." Taking care of your hands is chiefly a matter of taking care of your nails. Many people do their own manicuring. An important part of a manicure is getting the cuticle in shape. The cuticle is the thin skin that grows up over the base of the nail. It should be pushed back very gently. If it grows too high and some has to be trimmed off, the trimming should be done very carefully.

Many animals have the same special layer of skin that produces nails for us. Some animals have nails much like ours. Others have claws instead. Still others have hoofs. Nails, claws, and hoofs are made of the same material in the same way.

Apes have nails much like ours. So do most monkeys. Some monkeys have some flat nails and some claws. The walrus is another animal with some nails and some claws. Walruses have nails on all the toes of their front feet but have claws on some of the toes of their hind feet.

Lions, tigers, cats, and dogs are among the many mammals that have claws on all their toes. Birds, turtles, and lizards have claws on all their toes, too.

A great group of mammals have hoofs. The horse, as you know, is one of them. A horse, as it runs about, is really running on its middle toenails. (See HAND; HOOVED ANIMALS; SKIN.)



NAMES All places of any importance and all people have names. Trying to think how we could get along without them shows us how important names are. Suppose someone wants to send a letter to John Jones, who lives in Chicago, Illinois, at 5900 Blackstone Avenue. How impossible it would be without using his name and those of the city, state, and street.

No one knows how some names came about. But others are easy to explain.

The names of many places tell something about the places. A town on the bank of a river might very well be called River Town, or Riverton.

Mediterranean, Teddington, and Pacific are names that came about in much that way. "Mediterranean" comes from Latin words meaning "middle of the earth." In ancient times the world's leading countries were on the shores of the Mediterranean Sea. Teddington, a suburb of London, was once a small village on the Thames River. Tides in the river came up as far as the village. "Teddington" is short for "Tide End Town." "Pacific" means "calm." The Pacific Ocean is much calmer than the Atlantic.

Many early towns grew up around camps or forts. *Castrum* was a Roman word for "camp." *Castrum* became "chester" or "caster" in such names as Rochester and Lancaster. "Fort" is a part of many English place-names.

Many place-names begin with "New." New York, New London, and New Mexico are a few. They tell the story of the travels of people from place to place. Settlers in a new place often named it for the place they came from and added a "New."

"Franklin," one of the commonest names for towns and cities in the United States, was first used as a place-name to honor Benjamin Franklin. Countless places and streets have the names of famous people.

In the United States many names come from Indian words. "Wyoming" means "on the great plain." "Kalamazoo" means "where the water boils in the pot."

The longest place-name in the world is the name of a hill in New Zealand. It is "Taumatawhakatangihangakoauotamateaturipukapikimaungahoronukupokaiwhe-nuakitanatahu." It means "the brow of the hill where Tamatea, the man with the big knee who slid, climbed, and swallowed mountains, the discoverer of land, played his flute to his loved one." In contrast, a cape on one of the Caroline Islands is named simply U.

When people lived in small groups a simple name for a person was enough. In Bible times, for instance, a single name such as Jacob or Ruth was all that was needed. If there was doubt as to who was meant, the father's name could be given, too. James was the name of two of the Twelve Disciples—James the son of Zebedee, and James the son of Alphaeus.

Now with all the millions and millions of people on the earth, more complicated names are needed. In America everyone has two names and sometimes three or even more. The first is his given, or Christian, name. In a few cases it is only an initial. The last is his family name, or surname. A father passes it on to his children.

Indian children used to earn names for themselves as they grew up. A boy, for instance, might get a name by being brave or by running fast. In most parts of the world, however, the only given names people have are those their fathers and mothers choose for them when they are born.

Many first names had some meaning in the beginning. Ann came from the Hebrew word meaning "grace"; Clara in Latin means "bright"; Roy in French means "king"; and Stephen in Greek is "crown."

A first name may have different forms in different languages. Ivan (Russian), Jan (Dutch), Giovanni (Italian), Jean (French), Johann (German), and Juan (Spanish) are all forms of John. Hans (German) is a shortened form of Johann.

Last names came about in many, many different ways. Some have "son" at the

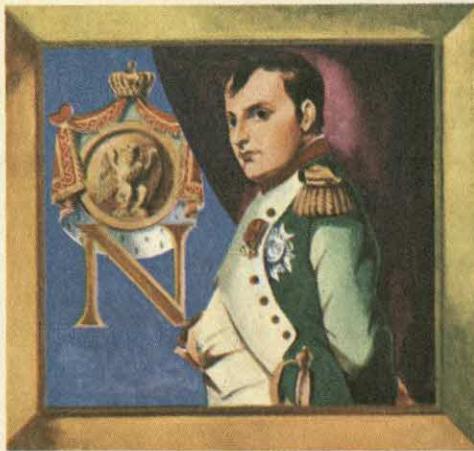
end. Johnson used to mean "son of John." Many came from occupations. Carpenter, Smith, Mason, and Taylor are a few. Some names came from the signs that hung over medieval shops. The name Rothschild means in German "red shield."

Some names came from the place where a man's home was. Wood, Green, and Ford are names of this kind. Some names such as Drinkwater and Playfair came from habits. Some came from the names of animals: Fitch, Fox, Wolf. Many first names were made into last names: Martin, James, Lewis, and Morris.

Names of people and places are called proper names. In writing, they begin with capitals. Every kind of plant and animal we know about has another kind of name—a scientific name. Scientific names are in Latin. Scientists all over the world use the same scientific name for a plant or animal. The picture shows a yellow-bellied sapsucker. Its common name is different in different languages. But all over the world its scientific name is *Sphyrapicus varius*. Many scientific names are long and hard to say. It is good that we do not have to use them all the time. It is certainly much easier and faster to say "dog" than to say *Canis familiaris*. (See LINNAEUS.)

Yellow-bellied Sapsucker





NAPOLEON (1769-1821) The full name of this famous soldier was Napoleon Bonaparte. His nickname was the "Little Corporal." He got this name because he was very short instead of being tall and impressive as many great soldiers are. He was only a little more than five feet tall.

Napoleon was born on the island of Corsica. Corsica is a part of France. Napoleon's parents were poor, but his father came from a noble Corsican family. The boy decided when he was very young that he wanted to be a soldier. A drum and a sword were his favorite toys. The books he liked most were about famous generals.

When Napoleon was only 15, he entered a military school in Paris. The other students made fun of him because he was so small. Napoleon was eager to show these boys that a good soldier did not have to be tall. This eagerness probably helped make him the great general he became.

After only a year in the military school Napoleon became a regular soldier. Soon he was an officer.

In 1789, when Napoleon was 20, the French people turned against their king. Their revolt is called the French Revolution. Napoleon fought against the crown. The king, queen, and many nobles were beheaded. France became a republic.

But when the French people set about ruling themselves they found that it was not easy. France's neighbors in Europe did

nothing to help. In fact, several of them declared war against France. To make matters worse, some Frenchmen decided after a very few years that the government should be changed again. Napoleon was called upon to put down this uprising. He did, and in doing so lost only 200 of his men. Everyone could see that he was a brilliant soldier. Although only 26, he was made the head of the armies of France.

Here was the leader the French were looking for. They were glad to follow him. Very soon he started a campaign against the neighboring countries. He led an army down to Rome and conquered all the northern part of Italy. The first step to power was so easy that he was eager to go on. He marched to the north, east, and west. In only about ten years almost all Europe except Russia was under his control.

All this while Napoleon was doing much for France besides leading her armies. He built roads, harbors, and factories. He drew up an excellent code of laws. He regulated taxes. He founded new schools. The machinery of his government moved smoothly. Everyone marveled at the amount of work he could do. One reason that he could accomplish so much was that he needed only four hours or so of sleep a night.

To some of the countries he conquered Napoleon was a hero. He freed them from leaders they did not like. To others he was a hated tyrant.



Napoleon gave France a new code of laws.

Napoleon became more and more greedy for power. He decided to become the emperor of France. As he was rising to power he had married the beautiful Joséphine de Beauharnais. He wished his wife to be an empress. There had to be, of course, a coronation. He sent for the pope to put the crown on his head. But at the ceremony Napoleon made the crowd gasp by taking the crown from the pope and crowning himself. He then crowned Joséphine.

Now that Napoleon was an emperor he needed a son that would follow him on the throne. After waiting over five years for one, Napoleon divorced Joséphine and married Marie Louise, the daughter of the emperor of Austria. Soon he had the son he



Napoleon crowned Joséphine empress.

wanted, and no baby was ever surrounded with greater luxury. Napoleon proclaimed his son king of Rome.

Finally Napoleon decided that he would conquer Russia. He marched as far as Moscow. But a terrible fire there and the bitter cold of a Russian winter did what armies of men had not been able to do. They defeated Napoleon's army. At last the French people realized that in Napoleon's campaigns half a million Frenchmen had been killed. They no longer had the heart left to fight. Many turned against Napoleon. They made him give up the throne. Again France had a king.

Napoleon was exiled to the nearby island of Elba. But he soon saw that the new king



In 1812 Napoleon retreated from Russia.

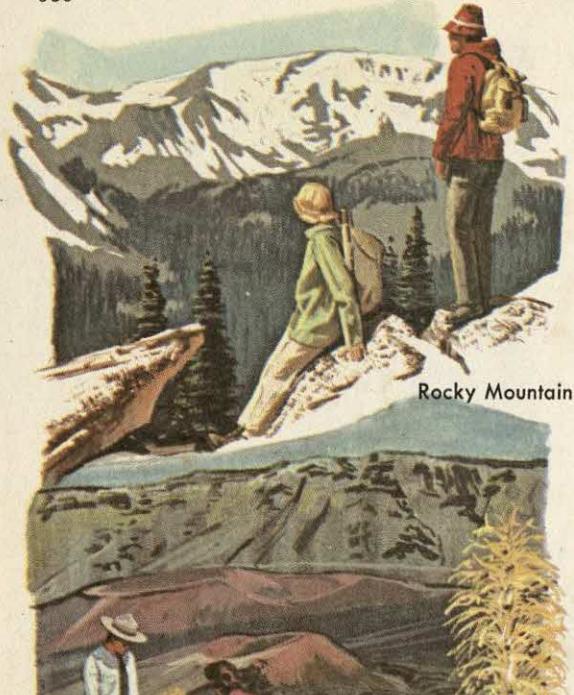
was not popular. He left Elba for France, and once more Frenchmen crowded to join him. Again he was the leader of a great army. Now, however, other nations of Europe were in league to overthrow him. When they began building up armies on the French border, Napoleon marched against them. He was defeated at Waterloo in Belgium by the British under Wellington.

After Waterloo, Napoleon gave up the throne and asked that his small son be made emperor. This request was not granted. Napoleon was exiled again, this time to the small, remote island of St. Helena. He died there several years later.

Napoleon was still a hero to the French. His body was brought back to Paris about 20 years after his death. Today his tomb is one of the most visited places in Europe. (See FRANCE; HISTORY.)



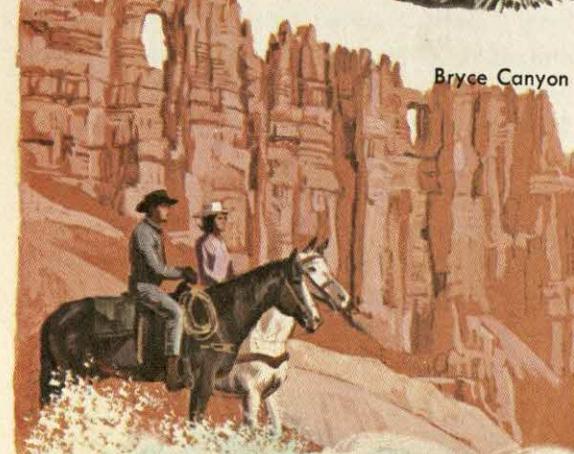
Napoleon was exiled to St. Helena.



Rocky Mountain



Haleakala



Bryce Canyon



Acadia

Sequoia

NATIONAL PARKS Some spots are so beautiful or so important in the history of the United States that the national government has set them aside to protect them. They are cared for so that everyone now and in the years to come can enjoy them.

Ranking at the top of these places are the national parks. There are also historical parks and sites, national monuments, military parks, battlefield sites, national cemeteries, memorials, and parkways. Altogether they make up the national park system of the United States. They are managed by the National Park Service.

The oldest of the national parks is Yellowstone. It was made a park in 1872. Now the United States has more than 30 national parks. Yellowstone, as the chart on page 958 shows, is still the largest.

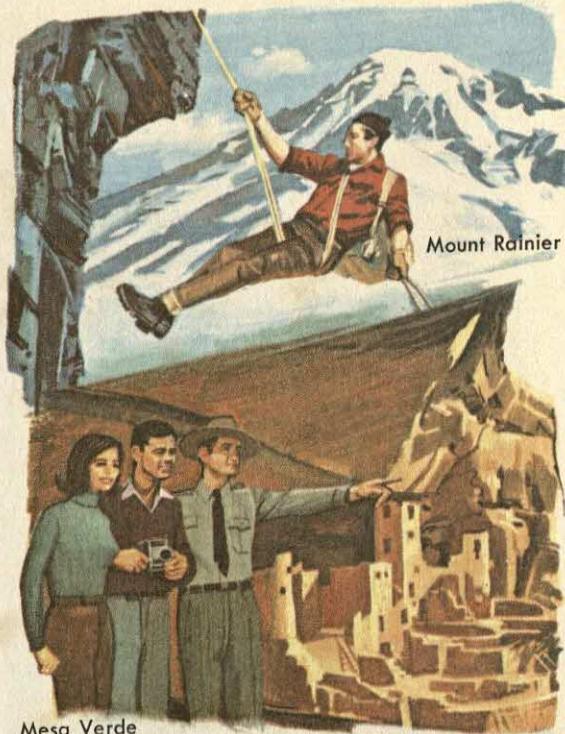
The government hires many workers to take care of its parks. There are scientists who know a great deal about wildlife. They see to it that animals in the park are allowed to roam and live as they would naturally live. There are scientists who know a great deal about the insects and plant diseases that might harm the trees

and wild flowers. There are scientists who know a great deal about the rocks of the region. There are rangers who see to it that visitors follow the park rules.

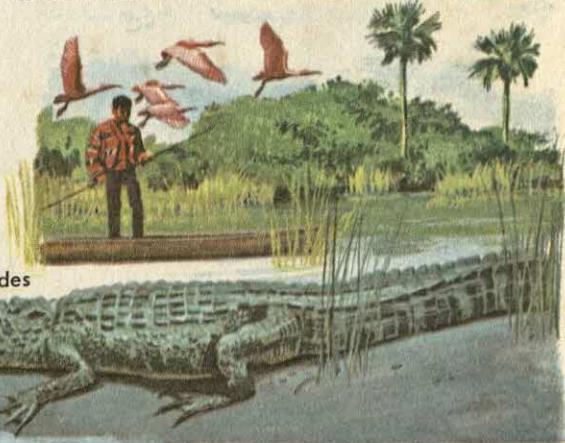
The national parks are wonderful playgrounds. In many there are places for campers. In many there are cabins to rent and lodges with dining rooms where visitors may stay as they do in a city hotel. There are wonderful opportunities for hiking, taking boat trips, swimming, exploring the wilderness, and even climbing mountains.

The parks, however, are more than just interesting and beautiful. They have been called the biggest summer school in the world. For in each park there are scientist-guides to explain to visitors what they are seeing. There are museums, too, with exhibits which show visitors how the regions came to be as they are.

Every year millions of visitors go to the national parks. The pictures give a little idea of what awaits these visitors. (See BIG TREE; CAVERNS; CONSERVATION; CRATER LAKE; DUNES; GEYSER; GLACIER; GRAND CANYON; HOT SPRINGS; ROCKY MOUNTAINS; VOLCANO.)



Mesa Verde



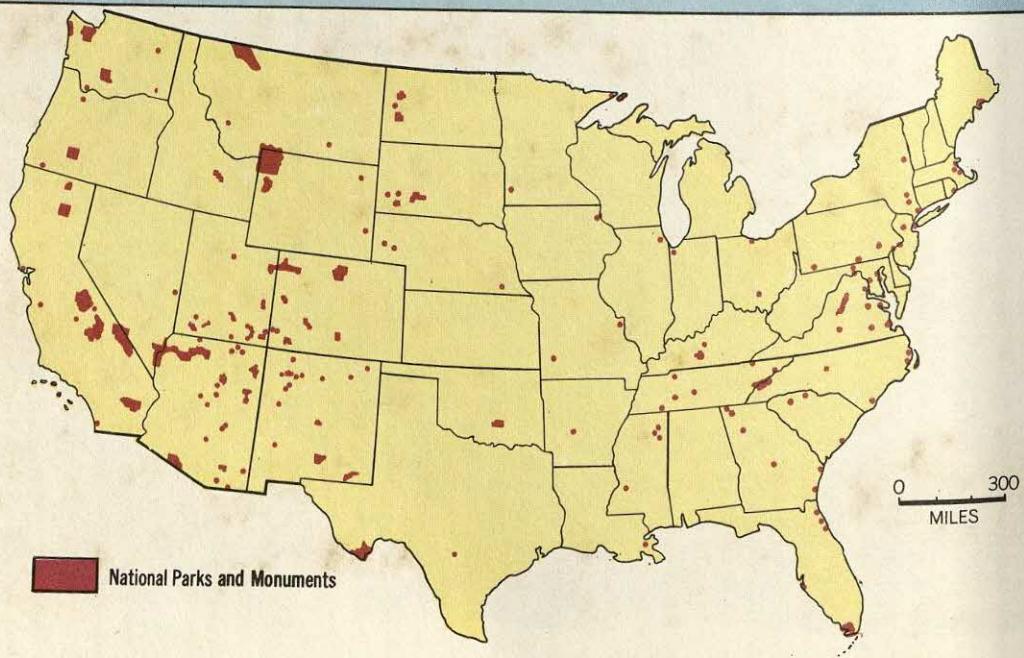
Everglades



Grand Canyon

NATIONAL PARKS

PARK	YEAR ESTABLISHED	AREA IN ACRES	CHIEF ATTRACTION
1. Acadia (Me.)	1919	41,634	Rugged seashore, Cadillac Mt.
2. Big Bend (Tex.)	1944	708,221	Mountains, canyons, desert
3. Bryce Canyon (Utah)	1928	36,010	Colorful rock formations
4. Canyonlands (Utah)	1964	257,640	Mesas and deep gorges
5. Carlsbad Caverns (N. M.)	1930	46,786	Enormous limestone caverns
6. Crater Lake (Ore.)	1902	160,290	Deep-blue lake in crater of dead volcano
7. Everglades (Fla.)	1947	1,400,533	Swampy areas with interesting wildlife
8. Glacier (Mont.)	1910	1,013,129	Mountains and glaciers
9. Grand Canyon (Ariz.)	1919	673,575	Magnificent mile-deep gorge
10. Grand Teton (Wyo.)	1929	310,350	Majestic mountain peaks
11. Great Smoky Mountains (N. C. and Tenn.)	1930	512,674	Unspoiled mountain wilderness
12. Haleakala (Hawaii)	1961	26,403	Spectacular view from summit of volcano
13. Hawaii Volcanoes (Hawaii)	1961	220,345	Two of the world's most active volcanoes
14. Hot Springs (Ark.)	1921	1,032	Many hot springs
15. Indiana Dunes (Ind.)	1967	8,700	Lakeside dunes, beaches
16. Isle Royale (Mich.)	1940	539,347	Wilderness solitude
17. Kings Canyon (Calif.)	1940	454,713	Peaks and canyons, sequoias
18. Lassen Volcanic (Calif.)	1916	106,934	Active volcano
19. Mammoth Cave (Ky.)	1936	51,354	Famous limestone caverns
20. Mesa Verde (Colo.)	1906	52,074	Cliff dwellings
21. Mt. McKinley (Alaska)	1917	1,939,493	Highest mountain in North America
22. Mt. Rainier (Wash.)	1899	241,983	Volcanic cone, glaciers
23. Olympic (Wash.)	1938	896,599	Rain forests, scenic seashore
24. Petrified Forest (Ariz.)	1962	94,189	Several "forests" of petrified trees
25. Platt (Okla.)	1906	912	Mineral springs, wooded valleys
26. Rocky Mountain (Colo.)	1915	262,324	High mountains, interesting wildlife, scenic drives
27. Sequoia (Calif.)	1890	386,863	Giant sequoias, Mt. Whitney
28. Shenandoah (Va.)	1935	212,304	Wooded mountains, Skyline Drive
29. Virgin Islands (U. S. Virgin Islands)	1956	15,150	Tropical plants, beaches, historic relics
30. Wind Cave (S. D.)	1903	28,059	Caverns in Black Hills, herd of bison
31. Yellowstone (Wyo., Mont., Idaho)	1872	2,221,773	Mountains, gorges, geysers, wildlife
32. Yosemite (Calif.)	1890	760,951	Mountain peaks, waterfalls
33. Zion (Utah)	1919	147,035	Deep gorge, colored cliffs, "temples" of stone





Rainbow Bridge

NATURAL BRIDGE In many places there are bridges that have not been built by people. These bridges have been carved out of stone by wind and water instead. They are called natural bridges or arches.

Water flowing underground through cracks in the rocks may form tunnels or caves. Later, part of the roof may fall in, leaving a bridge of rock across the top. Wind carrying a load of sand may blast a hole through a wall of rock. The rock above the hole is then a bridge or arch. Most natural bridges are in sandstone or limestone. These kinds of rock are soft and can be worn away rather easily.

One of the most famous natural bridges in the United States is near Lexington, Va. It is named the Natural Bridge. Cedar Creek flows under this bridge. The bridge is over 200 feet above the stream. It is about 90 feet long and is wide enough to hold a roadway.



Delicate Arch

Bryce Canyon, Utah, has the highest natural bridge in America. It is 8,000 feet above sea level. The longest one in America is also in Utah. It is very narrow, but nearly 300 feet long—almost as long as a football field. Landscape Arch is its name.

Almost on the southern edge of Utah there is a natural bridge which the Indians called Nonnezoshe. This Indian name means "hole in the rock." The bridge has now been named Rainbow Bridge because of the beautiful colors in the rock it is made of. Until about 60 years ago only Indians had seen this bridge. It is in a region very hard to travel through. But now that Lake Powell has been formed by the building of the Glen Canyon Dam, boats can come to within a mile of the bridge.

Rainbow Bridge is not quite as long as Landscape Arch, but it is more sturdy. Theodore Roosevelt called it the greatest natural wonder in the world. (See EROSION; NATIONAL PARKS.)



Turret Arch

All three of the natural bridges of Utah pictured are formed of sandstone.



Sandstone



Gas wells dot the landscape in the Southwest.

NATURAL GAS When pioneers first explored the Appalachians, their Indian guides had a strange sight to show them. In places there were fires that burned day and night where there seemed to be nothing to burn. No wonder the Indians were mystified! The fuel that was burning was one that no one can see. It was natural gas.

Almost 150 years ago the people of a small city in western New York discovered natural gas coming out of cracks in the rock along the banks of a nearby creek. They piped the gas into their houses and burned it for light. These New Yorkers were by no means the first people to use natural gas for lighting. Nearly 2,000 years before, some Chinese had found gas in the ground and sent it through bamboo pipes to their homes to burn for light.

After 1859, when Americans first began drilling for oil, natural gas came from many of the wells. Sometimes it caused explosions. Sometimes it caught fire and set fire

to the oil. To get rid of it, the oilmen piped it away and burned it.

It is not surprising that men found natural gas when they were digging for oil. For natural gas and oil were both made from tiny plants and animals that lived in the seas many, many millions of years ago. They are found in the same traps in the rocks deep underground.

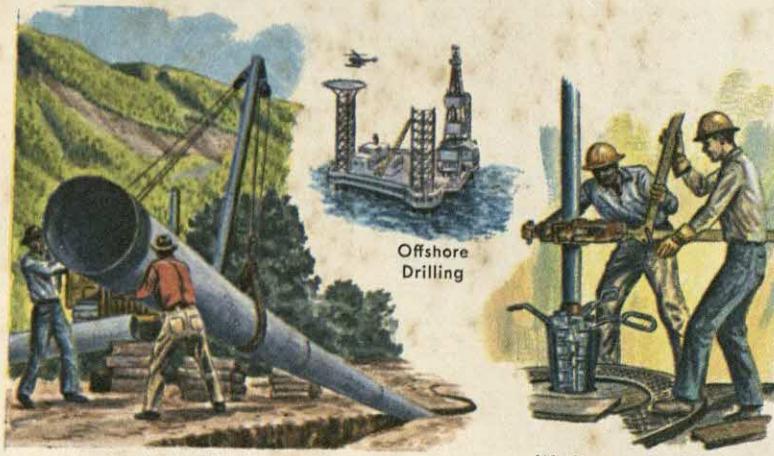
After a while the oilmen realized that the gas ought not to be wasted. Pipelines were built to carry it to places where fuel was needed. Now the United States has more than 200,000 miles of such pipeline. Natural gas is a very important fuel.

Texas produces more natural gas than any other state. California is second, and West Virginia third. From some gas wells no oil comes. Gas from oil wells has gasoline mixed with it. The gasoline is taken out before the gas goes into the pipelines.

Natural gas is clean. People like it as a fuel in their homes. Gas stoves, furnaces, water heaters, driers, and refrigerators have become common.

Some gas that comes from oil wells is not used. Some of it is pumped back into the ground to help force up the oil.

Natural gas is much more than one of our best fuels. Scientists have found that many different things, among them antifreeze, fertilizers, explosives, and refrigerants, can be made from it. (See FUELS; HELIUM; PETROLEUM.)



Laying Pipeline

Working on Derrick

